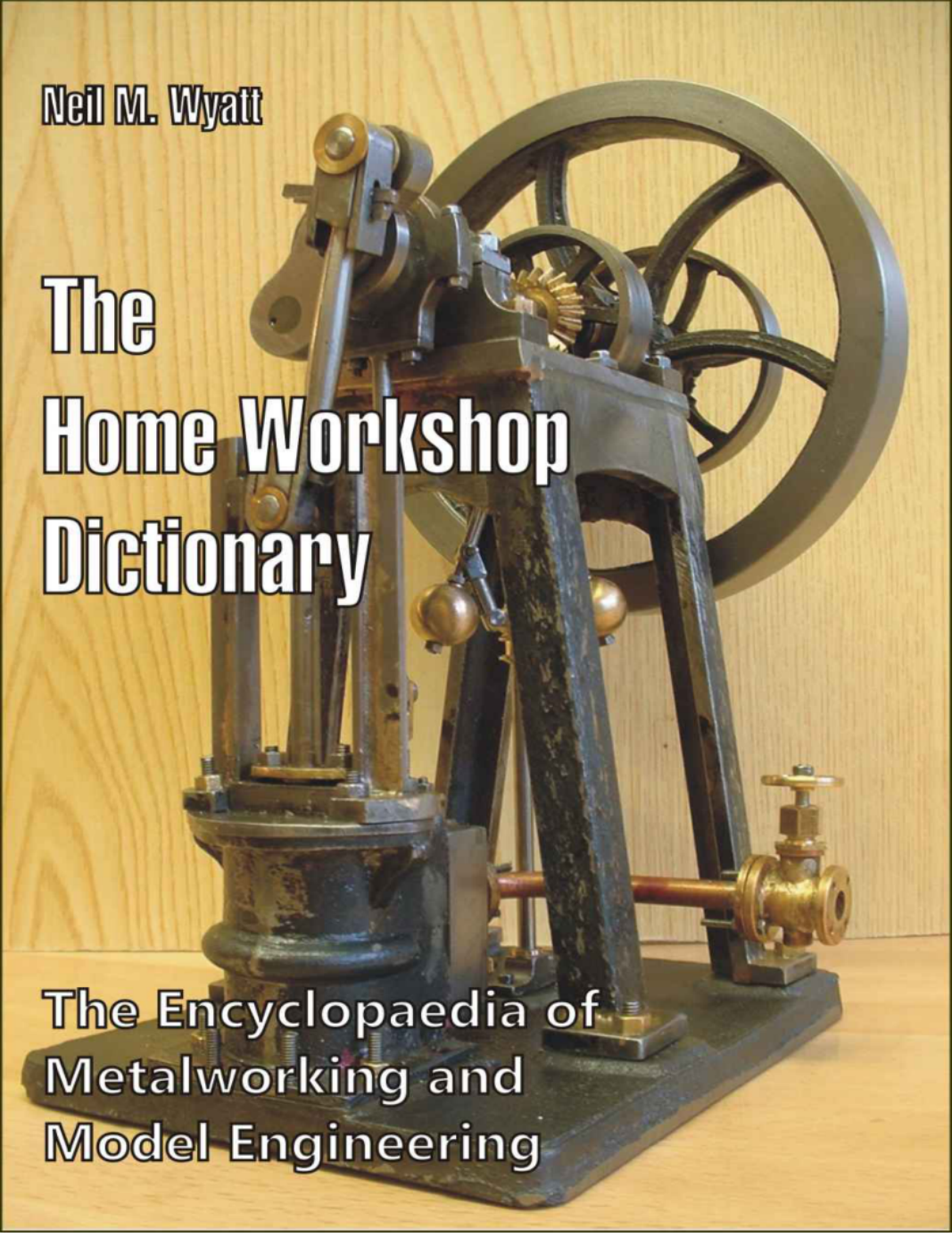
Neil M. Wyatt
The Home Workshop Dictionary
The Encyclopaedia of Metalworking and Model Engineering

The Home Workshop Dictionary

Neil M. Wyatt

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Contents

The Home Workshop Dictionary
Neil M. Wyatt

Introduction
A Few Notes
1- 9
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U

v

W

X

Y

Z

Introduction

This book is aimed at model engineers and anyone else who has a home engineering workshop. It is my attempt to provide a guidebook that would have helped me find my way through my first five or so years of the hobby, in the hope that it can do the same for others.

Writers in the model and hobby engineering press can't be expected to define every technical term they use. It would be boring and repetitive, and waste a lot of paper. It is also fair for them to assume a degree of knowledge on behalf of the reader. But when I was a new recruits to the hobby I often found myself confounded by some term that turned out to have a straightforward meaning. At other times I could see that words had a precise technical definition beyond their day to day use, and I wanted to know what it was. Increasingly, younger people are taking up the hobby and the explanation of some terms used in older writings may be useful. There are many excellent books on model engineering, and though some of these have excellent indexes, few have a glossary and none collects useful definitions of terms associated with the hobby. So to address this, over the last five years, on and off, I have been compiling this dictionary.

This book is not intended as a workshop handbook, so it is not full of tables and has only a few important formulas. Nevertheless, I have tried to pass on some of the hints and tips that I have picked up from other model engineers, and to reinforce a few messages of good practice that may be particularly useful to novices.

The field of 'home shop engineering', as it is called in the USA, is a vast one and this short book is really only a beginning. I am sure that any reader will be able to suggest many words and phrases that have been missed out, and no doubt will suggest others that should have been omitted. I have done my best to check my definitions, but anything that attempts to be comprehensive will contain some errors. These are my own, but if you find one please let me know.

Neil Wyatt

Branston, Staffordshire

2016

A Few Notes

In this dictionary, small distances are often quoted to the nearest ‘thou’ (0.001”). The precise metric equivalent is 0.0254mm, but this is excessive precision to use when the purpose is to give a general impression of the relative size of small distances. Depending on the context and the need for accuracy, I have used both 0.02mm and 0.025mm as a ‘metric thou’.

Within dictionary entries I have cross not cross-referenced every word that appears elsewhere. Words that may be unfamiliar or are used in a specific context that have their own definitions are in italics, as are words under which further relevant information may be found.

Where a word has several forms (asymmetric, asymmetrically) it is only listed under one form, thought either may be highlighted in bold in reference to the entry.

Sometimes, for clarity, I have added extra words in brackets after an entry. I hope these make sense in their context.

NMW.

1- 9

1-2-3 Blocks

A simple fixture that assists in setting up and laying out, consisting of a rectangular block with faces in the ratio 1:2:3. Inch dimensions make a convenient size. The blocks are usually drilled to allow flexibility in clamping and use as packing.

220M07

Modern designation for the general-purpose mild steel EN1A.

3-way toolpost

See Lammas toolpost.

4-way toolpost

See four-way toolpost.

5C Collet

A collet system based around a self-releasing taper. Unlike most systems, 5C collets may either be drawn into the taper by a normal drawbar, a special large tubular internally threaded drawbar, or may be held in place by a nosepiece. 5C collets are normally used for workholding, not holding cutters. As well round stock collets for hexagonal and square stock may be obtained, as well as ‘stepped’ collets for work larger than a standard collet. Soft unbored collets that may opened out to a non-standard size are also available. One feature of 5C collets is that various holders are available that can be used in place of machine vices, holding work sideways or on end. 5C fixtures with square or hexagonal bodies may be used to perform simple indexing

For example, a hexagon fixture facilitates the rapid milling of hex flats on round work.

A

A

Symbol for the unit of electrical current, an ampere.

Acid

A compound which releases free hydrogen ions when in solution. Acids attack more reactive metals, releasing free hydrogen and dissolving the metal as a salt.

Acme (thread form)

A thread with sloping, flat-sides and broad, flat crests that is very strong in tension and compression. It is commonly encountered on lead screws on machine tools and vices.

Acorn nut

A blind nut with a decorative finial on top. Acorn nuts have a practical application when the end of a thread needs to be protected or sealed.

Acute

Sharp; angled by less than a right angle (90°) the opposite of obtuse.

Adaptor

A device allowing objects with different fitting arrangements to be used together.

Addendum

The height of the teeth of a gear above its pitch circle. For gears to mesh accurately the addendum must be less than the dedendum (the depth below the pitch circle) by an amount known as the tooth clearance.

Adhesive

A substance used to permanently or temporarily join two surfaces by chemical or molecular adhesion.

Adiabatic

A system which does not lose or gain heat. In an adiabatic system the gas law can be assumed to apply perfectly. A concept used in theoretical calculations of the behaviour of gases. It is useful for internal combustion engines, for example, but not for steam engines where phase changes between vapour and liquid involve major heat transfers.

Adjustable die

A thread forming cutter with a slot allowing it to be slightly closed or opened up in a diestock to achieve accurate sizing of the thread

(contrast with a dienut). The teeth of a die are relieved so that the first few teeth do not cut to full depth. Sometimes dies are relieved on both sides, but normally the side stamped with the size of the die is fully relieved, the other only partially. This can be used to advantage when a thread right up to a shoulder is needed. The thread is cut normally, then the die is reversed and run up to finish to the shoulder.

Adjustable reamer

A reamer with a number of moveable blades arranged around a central mandrel, used in the same way as ordinary reamers. The diameter may be varied over a small range, and though it can be set to size with the aid of a micrometer, it is advisable to make a test hole before using an adjustable reamer for a critical purpose.

Adjustable wrench

A spanner-like tool that can be adjusted to fit different sizes of nut. Renowned for the ability of some modern designs and inferior types to round off the corners of a nut.

Adjuvant

A substance added to something to improve its performance.

Advance

The amount by which the spark of a four-stroke spark ignition engine precedes the point of maximum compression (TDC). The cylinder charge of an engine does not explode instantly, rather it burns in a controlled manner and correct advance allows the most effective use of the power produced. Hence, advance increases efficiency and promotes cooler running at higher speeds, but excessive advance will cause pre-ignition and knocking. Normally quoted as degrees (of rotation of the crankshaft) before TDC.

Aeromodeller

(1) One who models aircraft.

(2) A long lived magazine that followed the evolution of the hobby throughout the twentieth century. Despite covering the early development of radio control in great detail, with the great expansion of this area and the emergence of specialist RC titles it focused on free flight and control line modelling. By the end of the century it was faced with diversifying to cover areas such as model

rocketry and miniature RC systems. As its traditional audience of older modellers waned these changes failed to attract a new audience and it was eventually absorbed into another title.

Aeromodelling

The modelling of aircraft. The hobby of aeromodelling is usually considered separate from model engineering though many areas of the hobby involve model engineering skills. The finest model aircraft achieve standards of construction and finish equivalent to the best in other areas of model engineering.

Age hardening

A property of some metals, especially many aluminium alloys, that increase in hardness at room temperature, on a timescale of days or even hours. If they are to be easily worked they need to be annealed shortly beforehand.

Ageing

(1) The gradual recovery of a metal from internal stresses caused by rapid cooling or cold working at room temperature,(or faster at slightly warmer temperatures). It is a microscopic process that involves changes in the crystal structure of the metal.

(2) The relieving of internal stresses in an iron casting by a process of gradual rearrangement of the crystalline structure. It is facilitated by cyclical changes in temperature and may be promoted by seasoning a casting out of doors.

Air

The mixture of gases comprising the atmosphere. By volume air is about 21% oxygen and a little less than 79% nitrogen. The balance is made up of inert gases such as argon and increasing amounts of carbon dioxide, typically between 0.1 and 0.2%.

Air pump

A pump designed to move air rather than liquids.

Airbrush

Small spraygun for the application of paint, distinguished by sophisticated control over the flow and density of the medium.

Airbrushes that mix the paint and air internally generally offer better control than those with external mixing.

Aircraft

A machine that flies.

Air-hardening

In order to harden high speed steels they must be rapidly cooled from white heat. The use of oil or water baths for this purpose is impractical, and therefore a rapid blast of cool air is used. This requires the use of a special muffle furnace and the obtaining of annealed HSS. This may seem somewhat beyond the scope of the average hobby engineer, however, it was not a wholly uncommon practice in the past.

Airline

A pipe for supplying compressed air. Fixed airlines are usually made of metal, whilst flexible airlines are usually reinforced flexible plastic.

Alignment

In order to get the best out of any machine tool, it should be carefully set up to ensure the accurate alignment of its various movements. In the case of a lathe this can mean making small adjustments to compensate for any warping or ear of the bead, as well as ensuring the proper adjustments of slides and bearings. For mills with adjustable heads the process of tramming is used to ensure the spindle is normal with the table.

Allen key

A name for a type of hexagon key that has become synonymous with such tools in general.

Allowance

(1) The difference in size between two mating parts to give them the appropriate fit.

(2) Extra material on a casting or part to allow for machining or adjustment at a later date.

Alloy

A metallic substance comprising a mixture of two or more pure elements, at least one of which is a metal (but the others may be non-metallic elements such as silicon or carbon). Brass is an alloy of copper and zinc, for example. While the properties of some alloys are intermediate between those of their constituents, in some cases their properties are markedly different. For example, carbon steels and cast iron are alloys of iron and carbon in various proportions, with a wide range of properties depending on both the exact proportion of carbon and how the metals have been heat treated. A working knowledge of the commoner metals and their alloys is essential to the model engineer.

Alloy steel

A generic term for steels containing significant amounts of other elements in addition to iron and carbon. As well as stainless steels there are many, many such alloys optimised for various properties such as case hardening, wear resistance and tensile strength. Examples of metals used in alloy steels are: chromium, manganese, molybdenum, nickel, and vanadium.

Alternating current (AC)

An electrical signal or supply that periodically changes polarity. Ordinary domestic supplies are single phase AC, in which the live (line) conductor changes polarity relative to a fixed neutral conductor that is normally bound to earth at some point. Commercial supplies are typically three-phase.

Alternator

A moving coil electric generator that produces alternating current electricity. They are preferred to dynamos for most generating applications because they generally produce a higher output at low speeds.

Alum

Aluminium-potassium sulphate. A solution of alum has the property of corroding iron but not affecting aluminium, it may be used to remove broken taps or drills from aluminium parts.

Aluminium

A light, soft, metal, that resists corrosion by virtue of rapidly forming

a tough layer of surface oxide in air. A wide range of alloys of aluminium have been developed with various useful properties (such as ease of casting or ductility) have been developed that generally retain the positive features of corrosion resistance and lightness, but having much greater strength. Writers will often refer to ‘aluminium’, ‘ali’ or ‘ally’ as a shorthand for such alloys, but in reality pure aluminium is so soft it is rarely used as an engineering material.

American projection

Third angle projection.

American standard self holding taper

Three series of self-holding tapers in 22 sizes from 0.239” to 12” in diameter at the ‘gage line’. The taper is constant at 0.502” per foot for the smallest sizes and 0.750” per foot for the larger, but varies around 0.620” per foot for the medium sizes. They may have a driving tang, be tapped for a drawbar or rely on a driving key.

American standard steep machine taper

A series of self-releasing tapers (at 3.500” per foot) for machine tools.

American wire gauge

The transatlantic counterpart to standard wire gauge. Beware that though the numbers are similar, they are not directly equivalent.

Ammeter

An instrument for measuring an electrical current, also milliammeter.

Ammonia

A pungent, highly soluble gas that is a compound of nitrogen and hydrogen.

Amorphous

Without a definite shape; used to describe non-crystalline solids, such as glass.

Ampere (amp)

Unit of electrical current, symbol ‘A’.

Anaerobic adhesive

An adhesive that only sets in the absence of air, typified by the ‘Loctite’ series of retainers and glues.

Analemmatic Sundial

A sundial which uses a carefully calculated grid, on which the gnomon is positioned according to the date, to achieve considerably greater accuracy than a normal sundial.

Angle

(1) Corner, the point where two lines join.

(2) Metal bar of an L-shaped cross section, with increased resistance to bending. It is often used for structural components, or to join pieces of sheet metal.

Angle gauge

A device for measuring a fixed angle, normally a shaped piece of sheet metal or possibly resembling a try-square with an angled blade.

Angle iron

Angled (usually mild steel) bar useful for making structural members. Cold drawn angle iron has a good finish, but hot rolled angle iron is less likely to distort when machined; both types are often less accurate than you may expect. Precision ground steel angle is expensive, but can be very useful for making small angle plates and the like.

Angle plate

A rigid and accurate (often with a ground finish) metal frame with an “L” shaped cross-section, used as a fixture for mounting work for machining. They may have strengthening webs and usually are slotted or have threaded holes. Unfinished cast angle plates that can be finished in the workshop are readily available. Adjustable angle plates may be set to a range of angles, typically 0-90°.

Angular contact ball bearings

Ball bearings whose races are arranged so that they can take both radial and axial loads. They are usually to be preferred to ordinary ball races for machine tools and high speed spindles. Precision bearings of this kind are very expensive, but for general purposes magneto bearings offer an inexpensive alternative.

Anhydrous

Not containing water; used to describe crystals that have had any water of crystallisation driven off by heating.

Annealed

A (relatively) soft state in which a metal can be readily worked or formed.

Annealing

The process of putting metal into an annealed state. Changes in hardness of metals can be caused by either or both of grain effects and changes in the crystal structure. Most metals will work harden when beaten, drawn or bent and high carbon steels can be hardened by heat treatment, annealing offers a way of making them easily workable. High carbon steels are annealed by heating above the decalescence point and followed by very slow cooling (normalising, which simply corrects the grain structure to relieve stress in the metal can be achieved more rapidly with cooling in still air). Copper and brass can be readily annealed by heating to redness, rapid cooling is optional. If copper or brass are to be heavily worked repeated annealing may be required. Aluminium and its alloys need to be heated almost to redness, and one way of avoiding melting the metal is to mark it with soap, which chars at the annealing temperature. A characteristic of many aluminium alloys is age hardening, caused by changes in the crystal structure of the metal, which may take place over days or hours.

Anti-backlash gear

A gear designed to minimise backlash or lost motion. A typical design takes the form of two similar gears on a common axle, sprung so one of the pair is in full contact with the mating gear in each direction of rotation.

Anvil

A heavy metal block, often shaped with flat, round and pointed parts and used as a hard surface on which to work metal by forging. A traditional smith's anvil will have one or more hardie holes for special fitments used in metal forming and cutting. Many vices have a small anvil at the back of the fixed jaw.

The hardened face of a measuring tool, such as a micrometer.

Arbor

A spindle-shaped fixture for the attachment of tools or workpieces. Arbors with various fittings for cutters can be obtained, either with taper fittings or parallel shanks that may be held in a collet or a chuck. To fit inside and grip work with cylindrical bores expanding arbors can be purchased. It is also possible to grip such work by turning the end of an arbor to a force fit, using an adhesive or where possible using a bolt or nut. If an arbor drilled and a hole partially tapped, then slit across, it will expand a little when a suitable screw is fitted to it. Blank arbors can be obtained with tapers to fit most lathes and mills and have a cylindrical end that can be machined to suit various applications.

Arc

(1) A section of the circumference of a circle, defined by its radius and the angle between the points at its ends.

(2) A continuous electrical discharge, a long lasting spark.

Arc welder

A welding device that uses a low-voltage high-current electrical arc.

Archimedian drill

A small hand drill for very small drill bits with a twisted shank within a handle. Running the handle up and down the shank spins the drill back and forth.

Arris

(1) A sharp corner between two, flat or curved, surfaces

(2) An arrête. It is usual to 'break the arris' by putting a small chamfer on sharp edges. This is often done by draw filling with a few strokes of fine file along (not across) the edge. Alternatively a deburring tool can be drawn along the corner

of the work. Care should be taken on scale models not to create an out of proportion effect by being too enthusiastic.

Asbestos

A naturally occurring fibrous silica-based mineral. It has excellent insulating and heat-resisting properties and can be made into a self-hardening refractory putty by the addition of waterglass. Because of these properties it was widely used for many purposes including gaskets, heatproof tiles and garments, brakes and to reinforce structural materials. All types are associated with the deadly disease asbestosis, and as a result it has been replaced by other materials. Caution should used when dismantling old devices or structures that may contain asbestos. Small amounts of asbestos should be double bagged and disposed of at a council tip, which will normally have a special facility for its isolation. Larger quantities need professional attention. No single material offers a safe alternative for all the uses of asbestos, but there are suitable substitutes for any given use.

Ash

(1) A relatively light, flexible timber much used in the past for chassis and wheelwrighting. One of the UK's commonest trees, but under threat from a virulent fungal disease.

(2) The solid residue of combustion, The ash of coal fires can be harmful and care should be taken to avoid inhaling it.

Aspin. B. Terry,

A model engineer noted for his expertise and writings on small-scale foundrywork and large scale narrow-gauge locomotives. He was also the writer and illustrator of the Chuck series of cartoons in Model Engineer.

Assembly

The process of putting together the component parts of a mechanism.

Assembly drawing

A drawing whose purpose is to guide the constructor as to how the parts of a device are to be put together.

Asymmetrical

Different on either side; lacking symmetry.

Atmosphere

The body of gas surrounding the Earth and bound to it by gravity.

Atmospheric pressure

The force per unit area exerted by the atmosphere. Nominally 1014 millibars (1 atmosphere, 14.7 pounds per square inch) it varies considerably with altitude, location and the weather.

Atom

The smallest particle you can get if you divide something into ever smaller pieces without destroying the fundamental character of the ‘something’. The basic components of the elements, an atom has a central nucleus of protons and neutrons surrounded by a ‘cloud’ of electrons equal in number to the protons.

Atomic mass

The average mass of an atom of a particular element relative to the weight of a proton (a hydrogen atom with no neutrons), and approximately equal to the total number of protons and neutrons in the atom. Atomic masses are not whole numbers as some elements have isotopes with different numbers of neutrons, so it is an average value. When larger atoms are formed by smaller ones coming together by fusion they lose a little mass as energy, but nuclear fusion reactors are generally considered beyond the scope of model engineering.

Atomic number

The number of protons in the nucleus of an atom. Each element is characterised by its atomic number.

Austentite

A ‘solid solution’ of carbon in iron formed when carbon steels are heated above their decalescence point. Austentite is non-magnetic and a magnet can be used to detect the transformation. Rapid cooling of austentite prevents the reversion of the steel to softer pearlite, instead forming hard martensite (see hardening).

Autolock collet

A self-tightening milling cutter holding system devised by Clarkson that uses a combination of an internal thread and a cone fitting into the end of the cutter. This system gives a very secure, repeatable hold on the cutter, with low values of TIR.

Automatic centre punch

A centre punch containing an internal spring that, when pressed down onto a workpiece, delivers a firm but consistent blow to create an indentation without the use of a hammer.

Automatic feed

An arrangement for the self-powered movement of a workpiece and cutting tool relative to each other.

Awg

American wire gauge.

Axial

Along the long axis of a cylinder or spindle.

Axis

(1) The imaginary line around which a rotating part turns. One way of turning a taper is to offset the tailstock from the axis of the lathe.

(2) The centre line of a (usually cylindrical) part.

(3) One of the directions in which the bed of a machine tool may be moved. Usually (with respect to the operator) the X-axis is left and right, Y-axis is towards and away and Z-axis is up and down. In CNC machines forth and fifth axes are defined as the rotation of the workpiece and the toolhead. The plural is axes.

Axle

A spindle that supports a wheel.

B

BA

The British Association thread form and series of screw threads. Although the sizes of BA screws are often given in imperial units, the BA series was based on a continental standard starting with the largest, 0BA, 6mm in diameter and 1mm in pitch. It is, in fact, a metric system. Each successive BA number is 0.9 times the diameter and pitch of its predecessor. All BA screws have a 47.5° thread form. Because of this, all sizes of BA screw have well proportioned thread forms and they retain their popularity despite the availability of small metric threads.

Back gear

An arrangement to gear down the mandrel of a lathe, often by 2:1 or more, to allow much lower turning speeds for larger or demanding work. Most such arrangements involved a countershaft and gears mounted behind the mandrel, hence back gear. On some modern lathes with variable speed control it is beneficial to keep back gear engaged, except when very rapid speeds are required as this reduces the load on the motor.

Back off

To create relief behind a cutting edge to stop rubbing and promote free cutting.

Back splice

A technique for finishing the end of a rope, by laying it back on itself.

Backhead

The rearmost part of a locomotive boiler, projecting into the cab, in which the firehole is set and to which most of the fittings are attached.

Backlash

The amount by which the input end of a system of gears or screws has to move, following a change in direction, before the output end moves; a measure of the amount of slack in the system. Backlash is an easy way to introduce errors is working to the readings given on the leadscrew dials of a machine tool. It is also relatively easy to eliminate as a source of error if one remembers always to approach any critical reading from the same direction. If a reading is accidentally overshot, wind the leadscrew back at least a full turn before returning it to the correct position. Backlash is present in almost any such system unless special steps are taken to eliminate it such as sprung double gears, ball-screws or special nuts. When referring to linear systems such as levers and push rods as gears and screws it is more normal to use the term lost motion, though the overall principle is essentially the same.

Backplate

A special plate for a lathe that serves as an attachment for chucks. Although some chucks fit directly onto the spindle nose of a suitable lathe, many require a backplate which is essentially no more than an adapter between one type of fitting and another.

Bakelite

An early thermosetting plastic used for moulded components made by baking a phenolic resin.

Balance

a weighing device essentially comprising two pans suspended either size of a pivot one for the object to be weighed, the other for balance

weights. Balances may have many other elements to allow greater precision of measurement.

Balance weight

A weight whose function is to reduce imbalances or vibration in parts that cannot be eliminated through their design.

Balanced ball handle

A ball handle with a ball at each end, one of which serves as a counterbalance to the one bearing the handle proper.

Ball bearing

1. A precision sized ball (typically of hardened steel, but sometimes of ceramic or nylon according to duty and purpose)
2. A bearing consisting of a series of such balls running between two grooved races.

Ball ended Allen Keys

Hexagon keys with specially formed ends (usually only on the long arm of the 'L') that allow them to be used at an angle. They are very useful for working in constrained spaces or near to an obstacle.

Ball handle

A decorative while functional design of handle much used on machine tools that has the appearance of two or three balls along a conical shaft. There are three usual ways of making such handles: drilling and fitting suitable balls, using a ball turning attachment; and using a form tool.

Ball nose cutter

A round-ended slot drill (typically with two or sometimes three flutes) that acts a form tool cutting semi-circular flutes, recesses or fillets.

Ball pien hammer

A hammer with one end of its head in the form of a rounded ball, used for the beating and forging (cold or hot) of metal. With skill they can be used to form larger rivets.

Ball race

A hardened, usually steel, guide and load bearing surface on which ball bearings run.

Bandsaw

A powered saw that uses a blade in the form of a continuous band. In contrast to timber cutting bandsaws (which normally have fixed vertical cutting axis and the work is advanced into the blade), metal cutting bandsaws usually have a moving cutting axis and the work is held securely in a vice. Relatively inexpensive bandsaws are becoming widely available and can be a boon in the workshop, especially for making use of large but inconveniently sized offcuts or scrap.

Bandsaw blade

A continuous saw blade for use in a bandsaw. They typically have a pitch between 14 and 24 tpi (1.5-2mm). Lubrication, even applied by a brush, can help free cutting and extend blade life. It is important that bandsaw blades are properly tensioned to ensure long life and free, accurate cutting. Broken bandsaw blades may be repaired by grinding the two ends to make overlapping joint surfaces and hard soldering.

Bar bed

An economical way of constructing machine tools in which the main base is made around one or more accurately ground bars of simple cross-section, rather than a more complex casting. An example of such a machine is the Quorn tool and cutter grinder.

Barometer

A pressure gauge used for measuring absolute atmospheric pressure.

Barometric pressure

The pressure exerted by the atmosphere, nominally just over 1 bar or 14.7 PSI, but regularly varying by several percent with the weather. To calculate the absolute pressure of steam the barometric pressure must be added to the relative pressure inside the boiler.

Base circle

An imaginary circle used to generate the teeth of an involute gear.

Base circle

The imaginary circle at the base of the gear teeth, within the pitch circle, and from which the involute which determines the tooth shape of an involute gear is generated.

Bastard cut file

The coarsest grade of metal file, used for rough shaping and the rapid removal of metal.

Battery

A number of electric cells wired in series to give greater voltage.

Bauxite

The principle ore of aluminium.

BDMS

Bright Drawn Mild Steel.

Beam engine

A steam engine that incorporates a rocking beam as a key component of the link between crankshaft and piston. Usually the crankshaft and flywheel will be at one end of the beam and the piston at the other, but there are notable exceptions.

Bearing nut

A special type of collet nut containing a ball bearing to reduce the torque required to fully close a collet.

Beating

The shaping of sheet metal items with repeated small blows from a hammer or mallet. Planishing is a more developed and decorative example of beating.

Bed

The base of a machine tool.

Bel

See decibel.

Bell mouthed

Of a bore, opening out at the end, rather than being parallel. Bell mouthing is often the result of wear and can be particularly troublesome in elderly lathe or drill chucks, as it affects both their accuracy and grip. Increasingly replacement jaw sets for modern chucks are available at reasonable cost, but in the event that replacement is not possible, one cure is using a fixture to load the chuck jaws as if they were gripping a workpiece. The inner faces of the jaws are then ground in situ with a grinding stone held in a mini drill or similar.

Bell punch

A centre punch within a conical housing, used for marking the approximate centre of circular work.

Belt

See Drive belt

Bench brake

A bench mounted device for folding or bending metal sheet.

Bench grinder

A simple device consisting of an electrical motor with a long spindle, on each end of which are mounted grinding wheels. With a simple support they can be used for offhand grinding. Their flexibility can be improved with slightly more sophisticated support or jigs. For safety's sake they should always be used with undamaged wheels and all guards in place.

Bench shear

A device rather like a large paper guillotine used for cutting metal.

Bench vice

A vice designed to be attached semi-permanently to a work bench.

Bending

A process for shaping metal by deformation along an axis.

Bending brake

A device for making accurate folds (not large radius bends) in sheet metal for fabricating boxes and the like.

Bending rolls

A device using rollers to make large radius bends in sheet metal and bar, see Slip rolls.

Between centres

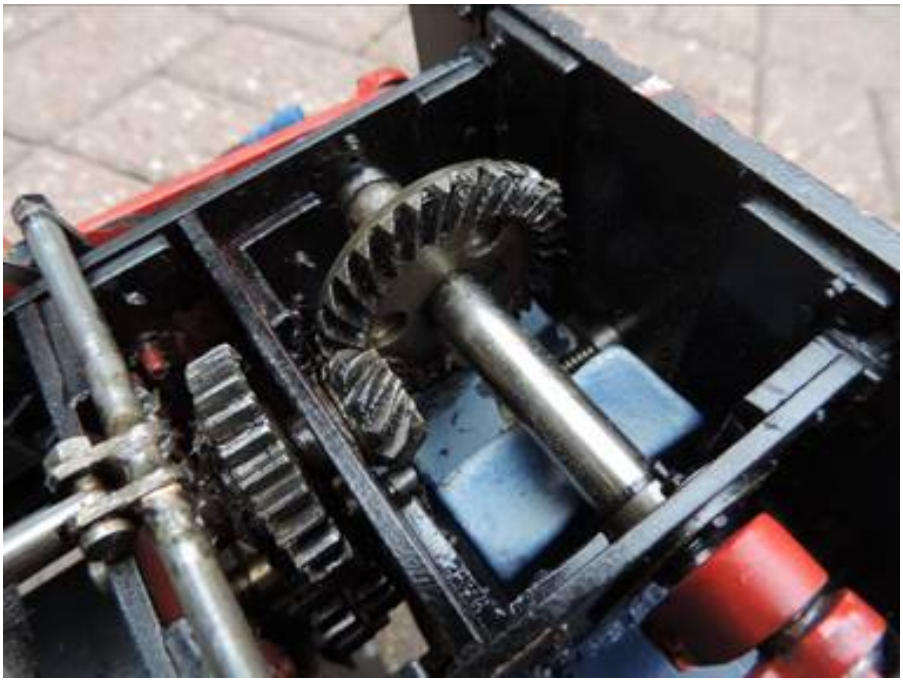
A technique for mounting parts in a lathe where a centre hole is formed at each end of the part and it is then held between a centre in the headstock and one in the tailstock. A lathe dog has to be used to drive the work. In theory turning between centres is the most reliable way of ensuring that all the outer surfaces of a turned part are perfectly concentric.

Bevel gauge

A protractor with both fixed and moveable blades allowing the rapid marking and measuring of angles.

Bevel gear

A gear wheel with the teeth arranged radially around a conical surface. The production of bevel gears is rather more involved than that of spur gears, but still within the scope of the home workshop.



BGSC

Back Geared Screw Cutting. The most essential features of a lathe suitable for model engineering purposes. Back gear is an arrangement to reduce the speed of the mandrel to allow larger or more demanding work to be done. Screw cutting requires the provision of a leadscrew to move the saddle, which can be geared to the mandrel in various ratios by means of change wheels.

Bhp

Brake horsepower, a measure of the useful power output of an engine.

Big end (bearing)

The crankshaft end or bearing of a connecting rod.

Bilateral tolerance

A tolerance on the size of a part that allows variation from the nominal size in either direction, for example 10mm +/- 0.06mm.

Bi-metal

Describes hacksaw or other saw blades that combine a flexible spring

steel back with tough HSS teeth.

Bimetallic strip

A device made of two complementary metals riveted, welded or otherwise joined together so that on heating they flex under the influence of differential expansion. Often used as a basic mechanism for thermostats and sometimes for thermometers .

Black Country

An urban district in the West Midlands including Dudley, West Bromwich, Walsall and parts of Wolverhampton comprising an endless succession of small settlements specialising in many aspects of metalworking as well as glassmaking and leather working.

Black mild steel

Mild steel that has been sized by rolling when hot, rather than drawn through a die when cold. It has a poorer surface finish, but far less internal stress than bright drawn mild steel and is much less likely to distort when machined. It is a good material to use for items requiring large amounts of metal removal. If black mild steel is unavailable for such items, bright drawn mild steel can be stress relieved by normalising.

Black wire corrosion

A form of electrochemical corrosion sometimes affecting copper wires left connected to a battery supply in slightly damp conditions for a long time. Black wire may either refer to the appearance of black copper oxide on the wires, or to the fact it normally affects the negative lead. As with the terminals of a car battery the effect can be mitigated by coating exposed terminals with petroleum jelly.

Blacking

A popular finish for metals that can be obtained in various ways. Chemical blacking kits are available for most common metals, alternatively steels can be blacked by repeated heating and plunging into oil. Both processes require a significant degree of care to avoid accidents.

Blacksmith

A craftsman skilled in the working of iron, typically in a forge.

Blacksmith's drill

Generally speaking large sized drills over 1/2"(25mm) with a reduced shank to allow them to be held in a standard drill chuck. Care should be taken when using such large drills as the torque and axial force they require can be huge and beyond the capacity of typical bench drills. It is best to drill out the hole in stages, so that the larger sizes are only cutting at the end of their flutes.

Blade

The working part of a cutting tool.

Blank

(1) A circular metal form, the starting point for machining many circular parts.

(2) A sheet-metal part to be finished by further working such as punching.

Blank arbor

A metal taper accurately ground to fit a taper socket on a lathe or mill with a machineable blank at the other end. Blank arbors can be used as the basis of various tools and tool or work-holding devices.

Blast pipe

An exhaust pipe for a steam engine arranged to blow up the chimney increasing the draught over the fire.

Blind hole

A hole that does not pass right though a component, that may or may not be threaded. It is useful to have a blower brush or similar gentle source of compressed air to blow dirt and swarf out of blind holes prior to assembly.

Block and tackle

An arrangement of ropes and pulley blocks to generate a mechanical advantage.

Blowdown valve

A valve designed to allow the rapid and forceful ejection of fluid in order to empty or clean a vessel or passageway, such as a boiler or a sight glass.

Blower brush

A soft brush with a rubber or plastic bulb attached that sends a jet of air through its hairs when it is squeezed. Obtained from photographic suppliers (they are used for camera cleaning) and useful for all delicate mechanisms.

Blowhole

A cavity within a casting. Normally, it is reasonable to expect castings to be free from significant blowholes. Cosmetic blemishes can be covered over with filler, but if they are in places that cause weakness or they affect machined surfaces most reputable suppliers will replace the defective casting. Sometimes the amount of work carried out on a casting makes repair, perhaps with a metal-loaded epoxy putty, a more attractive proposition if it is practical to do so.

Blowtorch

A gas powered torch used for soldering, brazing and the heat treatment of metals.

Blue annealing

A process for softening hot-rolled iron or steel sheet by heating it to a temperature of about 300˚c in air or dry steam. The blue colour is an oxide film accidental to the process, but is attractive and bestows a degree of corrosion resistance.

Blue steel sheet

Sheet steel that has been subjected to blue annealing. It is now virtually impossible to source, and its passing is much lamented by older model engineers.

Bluing

See blue annealing.

Blunt

With a rounded or obtuse end.

BMFA

British Model Flying Association

BMS

Bright Mild Steel. Alternative name for bright drawn mild steel. It is not an abbreviation for black mild steel (which is why BDMS is preferred as a less ambiguous set of initials).

Bobbin

A term used to describe parts that are shaped like a narrow cylinder with a flange at each end (like a sewing machine bobbin or a cotton reel).

Bodge

A makeshift solution, achieved using the materials to hand. It derives from the ancient art of bodging or the turning of green wood. To be classed as a true bodge a solution should be both effective and elegant in its simplicity, if not its appearance. Not to be confused with the derogatory term ‘botch job’, which implies the covering up of bad workmanship.

Body

Often used to describe the main component of a device or tool.

Boiler

A metal pressure vessel in which water is heated to produce steam. All but the smallest boilers require to be officially tested during construction and at completion so that an insurance certificate may be issued for them. This test then has to be repeated at specified intervals. Small boilers do not need such a certificate but should still have a hydraulic test to twice their working pressure before first use, and be periodically tested to one and a half times working pressure. The construction and operation of all but the smallest model engineering boilers is covered by detailed boiler codes.

Boiler

A pressure vessel used to heat water to produce steam. All but the smallest boilers should be made to properly checked designs and

subjected to pressure and steam tests before use.

Boiler Codes

Sets of written rules governing the construction and operation of pressure vessels. Before constructing a boiler advice on the relevant codes should be sought through a local club boiler inspector or similarly well informed source.

Boiler fittings

Various accessories such as valves, pressure gauges and sight glasses fitted to a boiler. It is important not to use ordinary brass for making these items as it can weaken considerably as zinc leaches into the hot water.

Boiler shell

The outer pressure-holding component of a boiler, not to be confused with the cladding, which is purely cosmetic.

Boiler stay

Reinforcing bars linking the inner and outer parts of a boiler. Used to support flat areas, such as flat sides of the firebox to its outer wrapper. For model boilers monel metal is sometimes used for stays.

Boiler tubes

Many boilers have tubes to increase the surface area for heat exchange. Fire tubes carry hot gases through the water body, whilst water tubes do the opposite.

Bolt

An externally threaded fastener that passes through holes in the parts it is fixing, and is secured with a nut, usually with an unthreaded, fitted section of its shank. Contrast with a screw which is fitted into a threaded hole.

Borax

Sodium borate, a substance traditionally used as a flux for brazing, and still a component in many contemporary fluxes.

Bore

(1) A hole or void through a workpiece.

(2) The process of making such a hole. When a hole has to be bored to an accurate size, it is best done using a single point tool.

Bore gauge

A gauge for checking the diameter of a bore. Such a gauge can made in a fixed size, or better still double ended, with one end say 0.006” (0.15mm) undersize and the other a close fit to the required size. Each test section of the gauge should be made approximately one diameter long, and be chamfered on the ends. Adjustable bore gauges are available commercially, using either a pair of opposed probes or a split ball end for smaller bores. The gauges are expanded into the bore then locked, and measured with a micrometer.

Boring

The enlargement of holes with the use of an adjustable single point tool, rather than a sized tool (such as a drill or reamer). The forces on a boring tool are typically constant and in combination with the provision for making small, precise adjustments to the tool this means boring is preferred as a method of producing a very accurate bore.

Boring bar

A rigid single point tool or tool-holder used to secure a single point tool. There are many designs of boring tool. Examples include: a once piece tool similar to a D-bit that may be held in a boring head in a mill; a once piece tool with an angled tip or an inserted cutting tool on a bar held in a split holder that may be used in the lathe toolpost; a heavy bar that may be placed between centres in a lathe carrying an inserted cutter. In the latter case, the work is attached to a boring table on the lathe cross-slide. Boring bars may be designed to be held in the toolpost or a boring head, or mounted between centres.

Boring head

A tool-holding device normally fitted to the head of a lathe or mill, and arranged to hold boring tools so that they can be adjusted radially. Normally a block with one or more tool holders is mounted on a base via sturdy slideways, and may be adjusted in steps of 0.001” (0.025mm) or less. A boring head is designed to rotate and cut holes in a stationary workpiece. Tubal Cain devised the simple but effective technique of mounting a centre in a boring head in the tailstock of a lathe, allowing it to be offset accurately and easily for taper turning. Boring heads may have a facility for auto feed, allowing them to be used for facing.

Boring table

A t-slotted table that is either an integral part, or attached to, the cross-slide of a lathe. Work secured to the table can be advanced past a tool on a boring bar or in a boring head to produce accurate bores.

Boring tool

See boring bar.

Botch

Covering up poor workmanship, such as hiding errors under paint.

Bottom dead centre

The position of a crankshaft when the piston of a single acting cylinder is furthest from the cylinder head.

Boulton. Matthew

Colleague of James Watt, and the main investor in his Soho Manufactury.

Box spanner

A cylindrical tool for tightening and removing hexagon nuts and screws, normally having a cross-hole for a tommy bar.

Box tool

A tailstock-mounted lathe tool that incorporates (as a minimum) a single-point cutter and a steady, used for running down round stock to a narrower diameter. In use the steady (which lies forward of the toolbit) is set for the stock diameter, and the toolbit is set for the desired small diameter. Used with a suitable stop a box tool is a quick and convenient way of reducing the shank of screws or similar parts while allowing tooling for other operations to be kept in the toolpost.

Boyle's law

A special case of the gas law that applies when its temperature remains constant (isothermal). It states that, for a fixed mass of gas at constant temperature, its pressure is inversely proportional to its volume.

Brake

A device for converting kinetic energy into heat, thereby slowing and stopping a device or vehicle.

Brake horsepower (bhp)

The power of an engine as calculated by using a power absorbing brake. Although a realistic measure of the output of an engine, it still suffers from the limitation of not allowing for transmission losses as it is generally measured at the flywheel.

Brass

Alloys largely of copper and zinc, with good strength, reasonable corrosion resistance and easily worked, although prone to work hardening. In regular contact with hot water zinc can be leached from the brass (de-zincification) leading to brittleness and failure so brass should not be used for boilers and boiler fittings.

Brazing

Hard soldering using brass as a filler metal. Brazing requires a higher temperature than silver soldering, but easily available borax can be used as a flux. A useful option for joining steel parts in an emergency.

Break

Archaic spelling of brake.

Bridgeport

A brand name that, through being a major supplier, has become synonymous with medium sized vertical (‘turret’) milling machines. Floor mounted and much larger than the typical bench mill a Bridgeport style mill would be at the large end of the model engineer's requirements.

Bright drawn mild steel

A plain steel that has been formed by drawing through a succession of dies. It is a cheap, clean, easily machined and readily available material and excellent for components that are not heavily stressed. Because of its method of manufacture it has high levels of internal stresses and may become brittle if cold worked. It is also liable to deform due to residual stress if it is machined asymmetrically, though this can be minimised by normalising it beforehand.

Bright mild steel

Alternative name for bright drawn mild steel.

Brine

A solution of common salt in water.

Brinell hardness test

To determine the Brinell hardness of a metal sample a hard ball bearing is pressed into a sample under great pressure, sustained for several seconds. The size of the bearing, the pressure and the diameter of the resulting depression are used to calculate the hardness of the sample.

Brinell number

A number indicating the hardness of a material, the higher the number the harder the material. It may be used for most materials, but is usually used for steels. A range of different steels might have numbers across the range 200 to 400.

Bringing to truth

The act of setting a workpiece so that further work may be carried out in alignment with already machined or marked surfaces. For example a cylinder may be brought to truth in a four-jaw chuck with a dial test indicator running against its bore, adjusting the chuck until the gauge shows no movement when the chuck is rotated.

British brass threads

A 26 tpi constant pitch series of threads with a 60° whitworth form.

British Model Flying Association

The UK umbrella body for flyers of model aircraft.

British Rail

A nationalised company that ran the railways for many years, including the transition from steam to diesel traction.

British Standard Fine (thread form)

The BSF thread form was devised to give a finer pitch alternative to BSW. The BSW thread form is rather coarse for many purposes, also a

finer thread is easier to cut and produces a greater force at lower torque.

British Standard Whitworth (thread form)

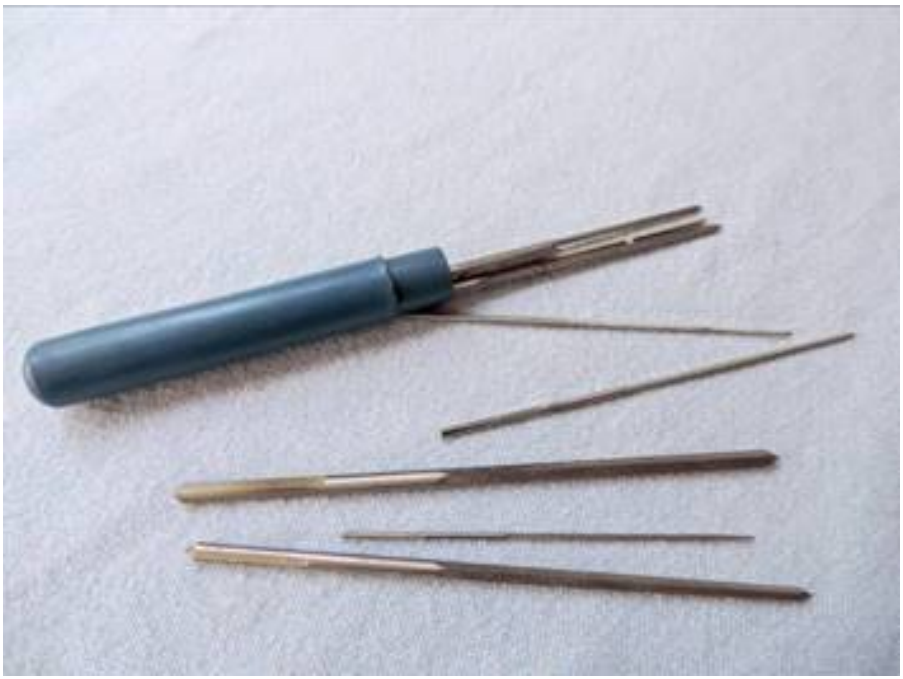
The first attempt at standard series of threads, devised by Josiah Whitworth and still in use today. He settles the shape, sizes and pitches of the threads after making measurements of many examples of threads from across various uses.

Brittleness

Brittle materials will snap rather than deform under stress, especially under shock loads. This is a property that often accompanies hardness and the process of annealing is used to reduce brittleness while retaining sufficient hardness.

Broach

A long, edge cutting, slightly tapered, straight fluted tool for enlarging holes. Unlike a reamer, which produces accurately sized holes, a broach is used on a cut and try basis to slowly enlarge a hole.



Broad gauge

Any railway of greater than standard gauge, most typically the original Great Western Railway as designed by Brunel.

Bronze

Alloys of copper normally containing tin as well as zinc together other elements such as phosphorus and aluminium. Bronzes tend to be much harder wearing and stronger than brasses and are better suited for use in contact with hot water.

Brown & Sharpe taper

A series of self-holding tapers running from 1 (the smallest) to 18. The taper is not constant but varies slightly around 0.500” per foot. They may have a driving tang or be tapped for a drawbar. There is also a stub series. They used on the shanks of many lathes and mills, particularly of north American origin. Unusual in the UK (except on some old lend-lease machines)

Browne and Sharpe Cutter

A generic term for circular, multi-tooth gear cutters.

Brunel. Isombard Kingdom,

Victorian engineer, designer of revolutionary steamships and architect of the Great Western Railway, Clifton Suspension Bridge and the revolutionary steamships S.S. Great Western, S.S. Great Britain and S.S. Great Eastern.. Allegedly a ‘great Victorian bloke’ though whether or not the 100 or so workers who died on his Box Tunnel project would agree is unrecorded.

Brushless DC motor

Electric motors that use either integral or stand alone controllers to provide unidirectional three-phase drive.

BSF

British Standard Fine one of the 55° Whitworth series of threads, with more closely spaced threads for any given diameter than the standard form.

BSI

British Standards Institution, the body which sets British Standards (BS).

BSP

British Standard Pipe, a thread standard the size of which relates to the bore of the pipe for which it is used.

BSW

British Standard Whitworth thread.

Buckle

(1) A failure mode in which a component bends out of shape, rather than breaking. It is typical of ductile materials in contrast to brittle ones.

(2) A hollow, rectangular component used to hold together the leaves of a leaf spring.

Buffer

A sprung pad used to reduce the shock when two object come together, especially as used on locomotives.

Buffer beam

The cross members at the extreme ends of the frames of a locomotive that bear the buffers.

Bull nose cutter

See ball nose cutter.

Bull pumping engine

A non-rotative beam engine with a low-pressure cylinder mounted at one end above a pump rod, and with a counterweight at the other.

Burnt

Describes the condition of a metal that has been overheated. It is particularly easy to burn out the carbon from the surface of silver steel when holding it at high temperatures for hardening. This can be

avoided by coating the part in a paste of chalk with water or methylated spirits before heating it. Brass can also have some of its zinc content burnt out of it by overheating.

Burr

1. A sharp edge left on the edge of material after it has been worked, caused either by deformation or the incomplete removal of chips. Excessive burrs are often a sign of a blunt cutter.
2. A rotary or many-fluted abrasive tool available in many shapes usually intended to be used for freehand shaping., such as blending in curves or fettling castings.

C

Cable

A cord formed by wrapping several wires, or smaller cables, together.

CAD

Computer Aided Design.

Cain. Tubal,

Pen-name of Tom D. Walshaw, an expert on diesel engines and one of the most accomplished thinkers and writers on model making issues. He was noted for the breadth and quality of his designs for stationary steam engines with a high level of faith to the originals.

Calliper

(1) A measuring device with two hinged legs used to transfer measurements between a rule and a workpiece. The legs may be have a stiff joint (friction callipers) or be sprung and have an adjusting screw. Internal callipers have two outward facing tips, external callipers two inward facing tips. Odd-leg or jenny callipers have one leg with a step at the end and a point (like dividers) on the other and are used for marking or measuring from an edge.

(2) A measuring device with a one fixed and one moveable jaw for external measurements (and often a pair of internal jaws and a depth probe). The moveable jaw gives a direct reading on a scale attached to the body of the instrument, but it may also have a vernier scale (vernier calliper) or digital readout (digital calliper).

CAM

Computer Aided Manufacture

Camlock

A method of attaching chucks using quick release cams used on larger lathes. Advantages of camlock systems are speed, ease of use and no tendency to come loose if the lathe is run in reverse or stopped

suddenly.

Camshaft

A shaft bearing one or more lobes (cams) that are used to impart linear motion to other parts, typically operating the valves in an internal combustion engine.

Capacitor start motor

A single phase electric motor that uses a secondary winding powered through a capacitor to assist it with starting. The capacitor may or may not be switched out with a centrifugal switch once the motor is up to speed.

Capillary

A narrow bore tube, typically of glass.

Capillary action

The tendency of a liquid to flow into narrow spaces under the influence of surface tension.

Carbide

1. A compound of carbon and a metal such as iron carbide (cementite), tungsten carbide or titanium carbide with a strong, hard crystalline structure.
2. A collective term for very hard tool materials in the form of various metal carbides. Carbide is generally harder and more wear and heat resistant than HSS, but more expensive and more difficult to sharpen.

Carbide file

A file for tough materials with the cutting surfaces covered with teeth consisting of small pieces of tungsten carbide bonded to the surface. These files are ideal for tidying up iron castings which often have a tough ‘skin’.

Carbide tools

Available in many grades and compositions there are three types of carbide tooling. Tipped tools have a steel shank with a piece of carbide brazed to the cutting end, indexable tools accept replaceable

inserts, and finally solid carbide tools. Carbide tools are more demanding than HSS tools, Most types of carbide tooling are designed to give their best results and finish when worked hard and fast in rigid and powerful industrial machines. They can be very disappointing when used with smaller machine tools. Compositions and tip geometries suitable for home use are becoming increasingly available and the advice of the supplier on the suitability of a particular type should be sought.

Carbon fibre

(1) Long fibres of nearly pure carbon with a structure that is intermediate between graphite and diamond and therefore have great tensile strength.

(2) A frequently used but technically incorrect term for composite materials made using carbon fibres as a reinforcement.

Carbon steel

Iron/carbon alloys with a carbon content of between roughly 0.2% and 2%. Steels with less carbon than this cannot be hardened by heat treatment (mild steels).

Carborundum

The very hard substance silicon carbide, though not suitable for making carbide tools in powder form it is used as an abrasive, often with a paper backing.

Carburising

The process of infusing the surface of a steel alloy with carbon. The first step in case-hardening.

Card

A backing sheet carrying numerous metal bristles used for cleaning files. Originally used for carding (aligning the fibres of) raw wool. An alternative approach is to use a piece of brass or mild steel.

Carrier

See lathe carrier.

Case

The outer layer of a steel object that has been subjected to case hardening. The depth of case will vary according to the method of case hardening, but 1/32” to 1/16” (0.8-1.5mm) might be typical. A case may also be formed on carbon steels if they are quenched slowly so that the inner core is not fully hardened.

Case hardening

A process for forming a hard surface layer (case) on steel components by increasing the surface carbon content. Typically the component is plunged, red hot, into a carbon rich powder one or more times, or it is packed with carbonaceous material in a sealed container and soak heated for some time. The part can then be machined before the case is finally hardened by quenching from a good red heat.

Cast iron

May be either iron direct from smelting, or may be ‘synthesised’ by dissolving carbon in molten scrap iron. It normally contains three to five percent carbon which may be in the form of graphite in a matrix of pearlite or as cementite, depending on whether it has cooled slowly or rapidly. The former is soft and gives a grey, easily machined material (grey cast iron), whereas the latter is very hard and gives a silvery-white intractable material (white iron). It is possible to control the rate of cooling of different parts of an iron casting using blocks of

metal (chills) in the mould. A bugbear for model engineers are small castings that are removed from the mould to soon, and cool quickly. These often have hard spots that can only be machined with tungsten carbide tools, though it is sometimes possible to remove them by annealing the casting in hot fire overnight (it needs to be brought to and held at a yellow heat, then cooled slowly). Longer, controlled heating can be used to increase the malleability and workability of cast iron, which is then known as meehanite or malleable cast iron.

Castellated nut

A nut with square notches around one end, allowing a split pin or wire through a hole in the screw to be used to lock it in position.

Casting

1. The art and science of making three-dimensional objects by pouring molten metal into a mould. The mould is typically made from a pattern, and any (intentional) cavities within the object are created by the placing of cores within the mould. Examples of casting processes are sand casting, lost wax casting, flexible silicon mould casting and die casting. Casting is a potentially very hazardous operation and more detailed guidance than this book can offer should be sought.
2. A component produced by such a process.

Castor oil

A strongly scented oil extracted from castor beans and often used as a lubricant in internal combustion engines.

Catchplate

A small, notched faceplate for a lathe used from driving work held between centres via a lathe dog.

Cell

A device for converting chemical energy into electrical energy. Several cells can be grouped to form a battery.

Celsius

A scale of temperature based on 0° = freezing point of water, 100° = boling point of water. Replaces the term centigrade.

Cementite

A hard compound of iron and carbon that is in common with all carbides, very hard. With Brinell hardness of about 550 It is much

harder than ferrite (90) and comparable to martensite (460 - 710). Pearlite (the annealed form of carbon steels) comprises a mixture of crystals of cementite and ferrite, with the latter predominating.

Centre

1. A (typically 60°) cone on the end of a taper, for mounting in a lathe. Dead centres may be soft (machineable) or hard. Live centres include a bearing so they can rotate freely under load.
2. A hole drilled in the end of a workpiece allowing it to be mounted on a centre.
3. The act of making a centre hole or of lining up the axis of a workpiece with that of a machine tool.

Centre distance

The separation between the axes of two gears, shaft, holes or other circular objects.

Centre drill

A stout drill with a short, rigid tip and a wider body that produces a conical depression with a centre hole. They normally have an included angle of 60° and can be used to make a suitable depression for use with a centre in the lathe. The central hole is doubly useful as it

ensures the centre fully engages the hole and can also act as a reservoir for lubricating oil. Because of their rigidity they are also used to accurately start holes, that may then be completed with a normal twist drill.

Centre finder

One of several simple devices or templates for locating the centre of circular work. One popular type works by allowing the scribing of accurate diameters across the work

The centre being at their intersection.

Centre gauge

A simple height gauge set to the centre height of a lathe and used as an aide for setting the height of tools and/or scribing across work at centre height.

Centre height

The height of the axis of the mandrel of a lathe above the shears; half the diameter of the largest object a lathe can swing between its centres. The figure usually quoted in the specification of British lathes.

Centre of gravity

Any solid object suspended freely acts as if all its mass was concentrated at one point, know as the centre of gravity (COG). The stability of an object may depend on its COG being correctly placed.

Centre punch

A pointed tool used for marking a workpiece, typically preparing the locations of holes to be drilled. A small, sharp prick punch may be used to mark the location accurately before using a heavier, more obtuse punch to enlarge the depression to facilitate the accurate starting of a drill.

Centre square

A type of centre finder, with a protractor and set square typically one of three tools in a combination set.

Centreless grinder

A specialist machine used to accurately finish cylindrical work by rotating it between control rollers and a grinding wheel. Under some circumstances, centreless grinding can produce work that is lobate.

Centreline

An imaginary line bisecting an object along its line of greatest symmetry.

Chaddock. Professor Dennis,

A model engineer particularly noted for designing the Quorn tool and cutter grinder.

Chalk

A natural form of calcium carbonate; a limestone that is almost entirely composed of the skeletons of microscopic algae. It has various incidental uses in model engineering.

Change wheels (gears)

A set of gears used on a screw cutting lathe to cause the leadscrew to rotate in different ratios to the mandrel, allowing screws of different pitches to be cut.

Charcoal

A relatively impure form of carbon formed by the incomplete combustion of organic material. Charcoal can be used as a fuel, but can also be used in case hardening.

Charge

1. The air and fuel mixture drawn into the cylinder of an internal combustion engine.
2. The explosive loaded into a gun.
3. Electrical energy stored in an object
4. To refresh the electrical energy stored by a cell or battery.

Charlotte Dundas

The first steam-propelled vessel.

Chassis

A discrete frame to which the running gear and bodywork of a vehicle are attached.

Chatter

The symptom, and sound of, a tool flexing under the load of cutting, moving in and out of the work giving rise to a poor surface finish. If, for any reason, a tool lacks rigidity it will tend to chatter. This will be most marked if a resonance is set up between the tool and the work, hence it can sometimes by avoided by changing the speed of cutting up or down. The ideal cure is a sharp, well supported tool and a rigid set-up, but there are times, such as parting off large diameters, when this is hard to achieve. Examples of ways of reducing chatter include: minimum tool overhang; adjusting all bearings and slides; tool shapes that reduce the length of the cutting edge; lubricating the cut more or differently; and, for parting off, the use of a rear toolpost. Under some circumstances increasing the feedrate can also help reduce chatter, as very fine cuts can be more prone to the vibration that causes chatter.

Chatter marks

Repeated striations or grooves on a machined surface, the visible consequence of chatter.

Cheese head

A type of screw with a head in the form of a short cylinder with a cross slot.

Chill spot

A hard spot in an iron casting, usually caused by too-rapid cooling resulting in bright, silvery patches of iron carbide that blunt tools very rapidly and cannot be easily machined. Extreme chill-spots can be considered a defect and most reputable suppliers will replace a badly chilled casting. For very small castings, a degree of chilling is inevitable and less extreme hard spots can be dealt by grinding or using carbide tooling. It is sometimes possible to deal with local hard spots by annealing a casting overnight in an open fire, but this can cause distortion in delicate castings. Some suppliers of small castings have them annealed under controlled conditions as a matter of course, but this adds significantly to their cost.

Chills

Metal blocks placed in the sand of a mould adjacent to areas required to have greater hardness in casting of cast iron. Chills are also used when casting aluminium, in order to minimise shrinkage and distortion.

Chine

A distinct corner between the bottom and sides of the hull of a boat.

Chip breaker

A grove or hardened attachment fitted behind the cutting edge of a lathe tool that prevents long chips forming by causing them to buckle and break. Carbide tools may have chip breakers moulded into their surface.

Chip guard

A protective screen to prevent swarf from being thrown towards the operator during machining operations.

Chopsaw

A circular saw arranged so that the work is held on its base and the

saw pivots down to make a cut. Chopsaws for metalwork tend to be relatively crude devices in comparison to metal cutting bandsaws.

Chord

A line joining two points on the circumference of a circle.

Chordal thickness

The straight line distance between the points where the two opposite faces of a gear tooth cross the pitch circle.

Chrome-molybdenum steels

Are strong but ductile. They are easily hardened and machined and are a popular choice for bicycle frames.

Chrome-nickel steels

Are alloy steels that are harder and tougher than plain carbon steels, but are more difficult to machine.

Chromium

A bright corrosion resistant metal used as a plating for bright metal parts, and a constituent of some alloy steels. Chromium steels are harder and stronger than plain steels, but are easily machined. It can reduce distortion when steels are hardened.

Chuck

A rotating workholding device. Typically a lathe will use a chuck that is effectively a rotating vice with three or four jaws which may be self-centring or act independently. Chucks with as few as two or as many as twelve jaws can be obtained. Drill chucks typically have three jaws and they are designed to take long thin material

They are also poor at withstanding side loads and should not be used for milling cutters. Milling cutters are typically held in various types of collet chuck which have excellent concentricity and rigidity. They can also be used to hold workpieces as well as cutters. Other types include master/slave chucks and tympan chucks.

Chuck backplate

See backplate

Chuck key

Most lathe and many drill chucks require a special key to enable them to be closed and opened properly. Lathe chuck keys typically have a square on the end, while drill chuck keys more usually have a crude bevel gear around a central pin. The ‘arms’ of a chuck key are typically chosen to make it impossible to overtighten the chuck by hand, do not extend the arms of a chuck key as this could stress the chuck. A vital safety precaution is to always remove keys before starting the machine.

Chuck the Muddle Engineer

A cartoon character accurately caricaturing the (mis)adventures of the average model engineer and his family. Chuck first appeared in the early 1950s. ‘Chuck’ is also a nom-de-plume of his originator B. Terry Aspin.

Chucking piece

An additional extension on a casting provided to make it easier to grip for machining purposes. The chucking piece can then be removed at a later stage.

Cigarette paper

A small piece, moistened with saliva, and stuck to a workpiece makes a useful method of edge detection. Cigarette papers are made to close tolerance (typically 0.001” (0.02mm) thick, but check your brand with a micrometer) so when a machine is started, and the tool advanced, it will lift off the paper when the tool is a small but defined distance from the work.

Circle

The shape enclosed by a line that passes through all the points on a plane that are equidistant from a single point.

Circular

Round, in the shape of a circle.

Circular pitch

The distance around the pitch circle between corresponding points on two adjacent teeth of a gear. For example, the circular pitch of a 20-tooth gear is 1/20 of the circumference of the pitch circle.

Circular saw

A saw with a circular blade. For home workshop purposes such saws range from large chopsaws down to small cut-off wheels for hand-held mini tools. Slitting saws and side and face cutters are precision circular saws normally used on a milling machine.

Circumference

The line enclosing a circle. The length of such a line, equal to 2 x pi x radius.

CLA

Centre Line Average.

Clack valve

A non-return valve that relies on a loose moving ball or plate. Named for the ‘clack-clack’ noise it makes when liquid is pumped through it by a reciprocating pump.

Clacks

Shorthand for water feed clack valves mounted on a boiler. They are usually low down and away from the hottest parts of the boiler to avoid the thermal shock of cold water hitting hot boilerplate.

Clamp

A device, either in one piece or with one or two moving jaws, for temporarily holding parts in place.

Classical style

Describes the decoration of columns and other parts of machines in a copy or pastiche of ancient Greek or Roman architecture, a particularly common practice in the 19th century.

Clay

Any of a huge number of complex minerals, formed by weathering, that have number of properties in common such as absorbing moisture and metal ions.

Cleading

Archaic variant of cladding, often used to describe the insulating layer and protective outer casing of a boiler or steam cylinder.

Clearance

The space between the bottom of the tooth spaces on a gear and the top of the teeth of the mating gear.

Clearance angle

An angle ground at the front or side of a cutting tool to prevent it from rubbing on the work, in order to promote free cutting.

Clock

1. A device for measuring the passage of telling the time.
2. Informally, any gauge or measuring device which gives a reading on a round dial.
3. The action of using such a device; I checked the truth of the cylinder in the chuck by clocking its bore.

Clockwork

1. The internal mechanism of a clock.
2. Any motor that stores potential energy in a wound spring, and releases it in a controlled manner using a series of gears.

Close running fit

A class of fit for mating parts that must retain good positional accuracy, whilst still being able to run relatively freely or bearing a moderate load. For a 1” (25mm) diameter shaft in a dead-size hole the shaft should be 0.0015” (0.035mm) oversize.

Close wound

Wound helically in a regular pattern without any gaps.

Clutch

A device for engaging and disengaging rotary motion along a shaft. Some lathes with larger motors are fitted with clutches, to reduce starting and stopping, which can cause the motor to overheat.

CNC

Computer Numerically Controlled.

Coal

A black or brown mineral composed largely of carbon with a high content of tar, oils and mineral ash. Coal is the fossilised remains of ancient vegetation deposited in swampy conditions and compressed and mineralised over many millions of years. Brown coal is very rich in tar and burns relatively cool, as coals get harder and blacker their energy content increases, with the finest being steam coal and anthracite. Heating coal in a poor supply of air generates drives off coal gas and tar, and leaves coke which burns hot and with little smoke. Coal was the chief power source of the industrial revolution, replacing the charcoal that had previously supported metal making and working industries.

Coefficient of friction

A constant for any pair of materials (assuming a smooth surface finish) that indicates the force required to overcome the friction between them as a ratio between the force causing and the motion force holding them together.

Co-efficient of thermal expansion

A property of a material that indicates the amount by which it expands when heated. For mild steel this is about 0.001% per degree C, and most metals expand rather more than this. Glass and wood expand less, and rubber has the unusual property of contracting when heated at normal temperatures, due to its unusual molecular structure.

Cog wheel

An old form of gear which has individually fitted teeth (cogs), rarely seen outside wind and water mills.

Coil spring

a spring in the form of a helical wire. Coil springs wound with their coils touching when not under load act as expansion springs. Those with open coils may act as compression or expansion springs.

Coke

A clean burning fuel produced by heating coal in the absence of air to drive off volatile compounds such as coal gas and coal tar. The invention of coke was a major step forward for the industrial

revolution as it could be used instead of charcoal for steel making.

Cold chisel

A tough chisel used on cold metal to cut or chip away material. The tip should not be ground to too sharp an angle or it will rapidly blunt.

Cold-working

The bending, beating, spinning or other shaping of metal without the use of heat, as distinct from forging. Typically cold working make a metal harder and more brittle.

Collet

A work or toolholding device for gripping work or tools placed in its central bore. Literally a ‘small collar’. It may be comprised of several moving jaws or be a split collet in a holder.

Collet chuck

A chuck for holding workpieces or tools by means of a collet. This may comprise either a removable split collet in a holder or a number of tapered jaws closed up by means of an external thimble.

Collet nut

A special nut for pushing a collet into its holder. The inside of the nut is shaped to match the collet.

Column

A vertical load-bearing structural member of a machine or building.

The main upright of a drilling machine or milling machine. For simplicity of construction, or to allow radial movement of the head, some machines have round columns. Square or prismatic columns are usually more complex, but ensure that the head remains in the correct position when raised or lowered.

Combination set

A set of marking out tools comprising a centre square, protractor and a try square that can be locked on to a precision steel rule.

Combustible

Capable of burning. For many types of internal combustion engine the stochiometric ratio of fuel to air is relatively critical to achieve a combustible mixture. Hence the development of relatively sophisticated carburettors for even relatively simple engines.

Combustion

Burning in air.

Comparator

A measuring device which indicates the difference in size between two items, rather than their absolute size. Specialist comparators are capable of detecting differences in size of tiny fractions of an inch, but other devices may be used as comparators, for example a surface gauge on a surface plate can be used to compare the height of parts with a precision ground gauge block.

Compass

(1) A device for indicating the direction of magnetic north.

(2) A device for marking out circles and circular arcs.

Compliance

A property of materials that distort relatively easily, for example fibre gaskets or washers that compress to allow a good seal between slightly imperfect faces.

Composites

Engineering materials that use a combination of materials to achieve special properties. Glass, carbon fibre or Kevlar reinforced plastic are obvious modern examples, but concrete, mortar and paxolin are others.

Compound

Chemicals that formed by the reaction of atoms of more than one element in simple, fixed ratios.

Compound angles

The arrangement of objects in space such that their relative positions are fixed by two or more angles, for example, the arrangement of cutting faces of a lathe tool. To produce such angles accurately it is normally necessary to have a machining set up with several degrees of freedom.

Compound beam engine

A beam engine with more than one steam cylinder, the steam passing from one to the next. See compound engine.

Compound gauge

A Bourdon gauge or other gauge reading both positive and negative pressure.

Compound steam engine

A steam engine with more than one cylinder that expands steam in

two or three stages, considerably increasing its efficiency. Compound engines typically work at higher pressures than simple (single-stage expansion) engines. A steam engine with two simple cylinders is not a compound.

Compound train

The series of gear wheels fitted to a lathe for the purpose of screwcutting or fine feed.

Compounding

(1) The use of a chain of gear wheels in order to obtain a greater reduction or an unusual ratio.

(2) The practice of using compound steam engines.

(3) The action of switching suitable equipped steam engines between simple and compound working.

Compress

To reduce the volume or size of an object under pressure, such as gas within a cylinder or a spring. Compressing an object has the effect of storing potential energy which may be recovered when it is allowed to expand.

Compressed Air

Air under pressure. Compressed air at modest pressures is useful for many purposes such as operating airbrushes and testing steam engines.

Compression

1. The reduction in volume of a gas or vapour under pressure. For most practical purposes liquids can be considered incompressible, which is why liquid trapped in a piston can cause significant damage.
2. The reduction in length of a compression spring under pressure.
3. A ‘squashing’ stress on a component due to a load, the opposite of tension.

Compression ignition

A way of achieving internal combustion that relies on the heating

effect of compressing a gas. Such engines typically have much higher compression ratios than glow plug or spark ignition engines. With sufficient compression, it is possible to ignite almost any fuel that can be mixed with air by this method. As well as the familiar diesel engine and the small two-stroke model engines using many different oils and even coal dust have been successfully burnt by such engines.

Compression ratio

The ratio of the total volume (unswept volume plus swept volume) to the unswept volume of an engine cylinder. For internal compression engines this ratio is critical to the most efficient use of fuel. In small compression ignition engines the compression ration may be varied with a contra-piston, an arrangement which can facilitate easy starting at lower compression while allowing fast, efficient running at higher compression.

Compression spring

A spring designed to work when a load acting to close up its coils is applied. It is usual for the last few coils of such a spring to be close wound, to improve its action.

Compressive stress

The load on a part under compression, measured in the same units as pressure.

Compressive ultimate strength

The compressive stress at which a material will fail. The equivalent of ultimate tensile strength for a material under compression, rather than tension. It is not often quoted for metals, but is critical for materials such as concrete (which is almost always used to bear loads under compression). Ductile materials swell or bend under compression and therefore do not have a compressive ultimate strength.

Compressive yield strength

The compressive stress at which a material will permanently deform, of greatest interest to architects and civil engineers.

Compressor

An air pump, usually coupled with a pressure vessel that smooths the output of the pump and acts as a reservoir, that serves as a source of

compressed air. Some small compressors for use with airbrushes and other devices with a low air demand, do not have a compressor.

Computer Aided Design (CAD)

The use of computers to assist with the design and drawing of engineering or other products. At its simplest this may be the use of a programme to produce drawings. At its most complex the parameters for a part (such as a gear or lever) may be entered into a programme that will then design a solution to fit the specification.

Computer Aided Manufacture (CAM)

The next logical step from CAD is the use of computers to take a digital design and turn it into a finished product using CNC machinery.

Computer Numerically Controlled (CNC)

Operated under computer control. CNC machines are essential for computer aided manufacture, but they may also be used just to simplify machining operations, for example by entering co-ordinates for a hole or a cut.

Con rod

The connecting rod of an (usually internal combustion) engine.

Concave

Depressed inwards, the opposite of convex. A useful mnemonic is that a cave goes into the ground, therefore a concave surface goes inwards. Concave lenses disperse light.

Condensation

The deposition of liquid water on cold surfaces when the atmosphere is near to saturation. Condensation is a major problem in workshops that suffer high humidity combined with rapid changes in temperature. If these conditions cannot be directly avoided on alternative is to use a dehumidifier to dry the air.

Condenser

A device, invented by James Watt, that reduces the output pressure and temperature of a steam engine by condensing the steam. By allowing the waste steam to be at a temperature below 100C, the temperature difference across the engine is increased, and so is its efficiency.

Conductor

A substance that readily allows the passage of energy as electricity or heat.

A wire or cable whose purpose is to carry electricity (e.g. A typical mains lead has three conductors, live, neutral and earth).

Cone

The solid of rotation formed when a right angle triangle is rotated along one of its short sides. Hence, it is easily fashioned on a lathe. Hollow cones may be fashioned by bending sheet materials (this is easiest when the tip or frustum of the cone is omitted).

Connecting rod

A bar connecting the crankshaft of an engine to the gudgeon pin or piston rod articulated with bearings at its extremities known as the big end and little end respectively. Because the connecting rod is articulated, it is necessary for the piston to be quite long (typically at least one diameter) to prevent misalignment in the bore.

Constant

A number in a equation that does not change. In many equations that describe the behaviour of physical systems constants appear whose value has a particular meaning. Such constants may be universal or may be specific to certain materials or circumstances (such as the coefficient of thermal expansion for different materials).

Contactor

A heavy duty relay, pneumatic or electromagnetic switch, used to switch high currents such as in the control of high-powered electric motors.

Controlled cooling

A process to prevent the inadvertent hardening or cracking of hot metal after heating. An essential part of annealing and normalising, and a contrast to quenching.

Convention

An accepted way of doing or representing something, often arbitary, but nonetheless normal practice. For example it is conventional for screw threads to be right-handed (other than in a few special circumstances). Though there is no physical reason why this must be so, but imagine the consequences if each screw on a device was handed randomly! On engineering drawings objects such as gears, threads and springs may be represented conventionally, that is in a stylised form that is generally understood, rather than being drawn accurately.

Converter

See adaptor.

Convex

Bulging outwards, the opposite of concave. Convex lenses (such as magnifying glasses) converge light.

Coolant

A substance, usually a fluid, sometimes a paste with a volatile content, used to remove excess heat, particularly from cutting tools. Most cutting fluids act to some degree as both coolant and lubricant, though which is the more important effect will depend on circumstance.

Co-ordinate working

A way of producing complex shapes by taking a series of cuts according following a calculated a series of co-ordinated points. The resulting shape will often have many steps or facets and may need hand finishing to give a satisfactory result. CNC machines use co-ordinate working at very fine step sizes, often with round ended tools, to produce good results that would generally be impracticable to achieve by hand.

Coping saw

A medium sized saw that takes narrow blades about 8” (200mm) long. Depending on the blade they may be used for making curved and intricate cuts in sheet or thin metal or in wood. Coping saws may also be used to hold abrafiles and other radial cutting blades that cut in any direction.

Copper

A reddish, malleable metal which has good corrosion resistance, low thermal and electrical resistance and easily annealed by heating to a red heat. Its properties, not least its slight deformation reduce stress when first loaded, make it highly suitable for making pressure vessels such as boilers.

Copper sulphate (CuSo4)

A blue (in its typical hydrous form) crystalline salt, readily soluble in water. A traditional alternative to marking blue, if a reasonably strong solution of copper sulphate is wiped onto clean iron or steel it will deposit a tin layer of metallic copper that shows scribed lines clearly. Care should be taken as copper sulphate is poisonous.

Copper washer

Annealed copper washers are useful for making a water or gas-tight seal between a screwed fitting and its seat, such as an oil drain plug.

Coppersmith

A craftsman skilled in the working of copper and its alloys such as brasses and bronzes.

Core

The softer, more ductile interior of a piece of steel with a hard outer case. (2) A separate piece placed into a mould in order to create a void in the final casting.

Core diameter

The diameter of the solid, central part of a screw thread, the distance between the bottom of the thread on opposite sides of a screw.

Core drill

A hollow cylindrical drill that cuts a circular slot and removes a plug

of material (core).

Core hole

The cavity left in a casting by a core. Care should be taken when opening up core holes as they may have a hard skin or be contaminated by moulding sand, either of which may blunt tools. As cores are rarely placed with extreme precision, it is not unusual for core holes to be off centre, it is often advantageous to plug a core hole with wood and mark off the true centre of any required hole from the edges of the casting.

Core plug

A plug fitted to the cylinder block of an engine or other complex casting to fill a hole made by the support for an internal core.

Core print

A cylindrical protrusion on a moulding pattern to facilitate the fitting of a core to the mould.

Core size

The diameter of the central core of a threaded object; its overall diameter less twice the depth of thread.

Corliss valve

A type of steam engine valve that uses rotating bobbins to control the flow of steam. The rapid action makes these valves suitable for very fine control as seen in many mill engines.

Cornish boiler

A horizontal stationary boiler with a single furnace tube along its length.

Cornish pumping engine

A non-rotative beam engine with a low-pressure cylinder at one end and a pump rod at the other.

Corrosion

The erosion of a material by chemical means. In the case of metals

corrosion is typically an oxidation process (e.g. Rusting), but metals can also be corroded by acids and other strong chemicals.

Corrosion resistance

The ability of a material to withstand chemical attack.

Cosine

For an acute angle in a right-angled triangle, the ratio of the adjacent side to the hypotenuse. Used in various calculations, including setting out holes in a circle using co-ordinates.

Counterbore

A hole-cutting tool with a central pilot, designed for opening up a hole at its end, so that it can accommodate a screw head, for example. The holes produced by such a tool. There is little practical difference between a spot-facer and a counterbore, aside from the latter being produced in standard sizes to match available screws.

Countershaft

A second shaft geared or belted to another, normally as part of an arrangement to vary speed or power.

Countersink

A conical depression or a drilling tool with one or several cutting edges used for making such holes to accommodate the heads of countersunk screws or rivets. Normally the countersink has an included angle of 90°.

Countersunk screws

Screws with heads having the underside with an angle, typically 90°, so that they can be sunk into a suitable depression in a surface, allowing them to hold it without protruding.

Counterweight

A weight whose function is to overcome the opposing weight of some part of a mechanism. Because scale models are typically far lighter than their prototypes counterweights are often not truly functional.

Crack

A fracture in a material. Within brittle materials stress is concentrated at the end of cracks, so once they have started they can spread rapidly leading to complete failure. It is sometimes possible to stop them spreading by drilling a well-finished hole just beyond the end of the crack.

Cracking

The first process in the refining of crude oil. Heat in the presence of a catalyst is used to break long-chain hydrocarbons down into shorter, more volatile, and more valuable ones.

Cramp

Clamp. A word falling into disuse, particularly in the field of metalworking, but still used by many woodworkers.

Crampton

An early design of locomotive renowned for its speed, popular on the continent, especially on broad gauge railways. Typically characterised by external frames and cylinders, with the cylinders near the centre of gravity of the engine, although some had internal cylinders and a jackshaft ahead of the firebox.

Crank

An arm bearing an offset journal in order to convert reciprocal motion to rotary motion, or the reverse.

Crankcase

In engines with an enclosed crankshaft, the lower part of the main body in which the crankshaft bearings are fixed.

Crankshaft

A shaft with one or more journals offset from its main axis. Such a shaft is typically used to convert reciprocating motion from a piston or other source into rotary motion.

Critical temperature range

In the context of heat treating metals the temperature range over which a metal changes from one phase to another.

Cross compound engine

A compound steam engine in which the high and low pressure cylinders lie on opposing sides of the flywheel.

Cross drilling

The making of holes across the axis of cylindrical work. Whilst this can be done by eye it is often necessary to cross drill with a fair degree of accuracy. There are too many ways to achieve this to list, but they fall into two main groups: those that rely on measurement to align the drill with the work, and those that depend on some sort of jig.

Cross-hatched

Patterned with two sets of parallel lines more or less at right angles to one another.

Crosshead

A device fitted to the end of a piston rod that usually combines the roles of the joint with the connection rod and that of aligning the piston rod with the guide bars.

Cross-slide

A moving machine table arranged to move at right angles to the main motion. On a lathe the cross slide is mounted above the saddle and moves back and forth across the shears.

Crown wheel

A gear wheel with its teeth arranged on a thin rim turned up at 90° to the plane of the wheel. Such gears are less robust than bevel gears but can also be used to turn rotary motion through an angle.

Crucible

A heatproof container used to hold metals for melting prior to casting.

Crystal

A material with a regular structure deriving from and reflecting the arrangement of its constituent atoms.

C-spanner

A spanner with a curved cutout at one end bearing a single tooth or peg. In use the peg is inserted in a slot or hole in a matching part, whilst the curved section bears on its outer surface.

Cube

A regular solid with six square faces.

Cup wheel

A grinding wheel in the shape of a concave cup with sides in the form of a cylinder or a truncated cone. Such wheels offer greater flexibility in how they can be approached and are therefore often used on tool and cutter grinders.

Curly Bowl

The LBSC Memorial Bowl Competition, an annual event celebrating the designs of Lillian Lawrence (LBSC).

Cut

1. The action of removing material with a sharp-edged tool.

2. The result of making such an action.
3. The grade of a file e.g. A smooth cut file.
4. The water-filled part of a canal.

Cut and try

One of the techniques of hand fitting, where a part is brought to size by a process of removing small amounts of material and checking the fit each time. In the absence of suitable measuring equipment or gauges, cut and try may be the only way to achieve a close fit for items such as pistons in their bores. It may also be the only viable way of fitting complex sheet metal covers to three-dimensional parts where producing an accurate development is impractical. It is a slow technique and not suitable for parts that need to be interchangeable.

Cut off

The point in the stroke of the piston of a steam engine where the valve closes and stops the admission of steam.

Cutout

1. An electrical device that removes power from a machine tool when it is overloaded or overheated.
2. A hole or pocket in an object.

Cutter

A tool that removes material by forcing its edge through the work.

Cutting speed

The rate at which the cutting edge of a tool moves through the work. Each combination of different materials and tools has a different ideal cutting speed, normally a compromise between tool life, surface finish and rate of metal removal. In model engineering cutting speeds are normally lower than in industry in order to maximise tool life. In practice the calculated optimum cutting speed is often best tempered by experience to suit the job in hand. In a lathe the cutting speed is determined by the diameter and rotational speed of the work, in a mill the diameter and rotational speed of the cutter. Within reason, as diameters increase, the speed of rotation should decrease in proportion.

Cyanide

A compound of carbon and nitrogen, of very high toxicity.

Cyaniding

The simultaneous carburising and nitriding of steel by heating it in a cyanide salt. Because of the risk of poisoning this is not a process recommended for the home workshop. Some traditional case hardening compounds have been reformulated to reduce their toxicity.

Cyanoacrylate

A polymer that sets very rapidly in the absence of air, and even more quickly when catalysed by metals. Cyanoacrylates are the basis of so-called ‘superglues’. Such glues can have very high strengths, especially when used to join large flat areas. They lose much of their strength on heating to moderate temperatures, a useful property as it facilitates their use for temporarily holding parts in position for machining.

Cycle

A regular series of events happening in an engine or other mechanism, for example the four-stroke cycle.

Cycloid

The path followed by a point on a circle as it rolls over a surface.

Cycloidal gear

A gear with the shape of its teeth in the form of a cycloid. Cycloidal gears are much used in clockmaking, where it it is normal to take pains to adjust gear spacing precisely. The form of driving and driven gears can be modified for any given arrangement, even to the point where one set of teeth become circular pins as in a lantern pinion, resulting in low friction. These bring further benefits for clockmaking where the ability to make gears of greatly varying size with a limited range of cutters is helpful. In normal engineering use involute gears are to be preferred, on reason being that they are less critical with respect to gear spacing.

Cyclone torch

A type of blowtorch that sucks in air near the base of the gooseneck and produces a whirling flame. It is useful when it is needed to produce a fierce flame within a confined space as it doesn't starve itself of oxygen.

Cylinder

1. A prismatic shape of circular cross section.
2. A part with a tubular cavity within which a piston reciprocates.

Cylinder block

A part containing one or more engine cylinders, particularly in internal combustion engine terminology.

Cylinder cock

A drain cock fitted to the end of the cylinders of a steam engine, and used to allow the water that condenses in the cylinders when starting from cold to drain away to avoid creating a hydraulic lock. Engines with slide valves do not generally require cylinder cocks (though they may be fitted as a precaution) as trapped water can escape by lifting the slide valve from its seat. Sprung automatic cylinder cocks are fitted to some engines.

Cylinder covers

Circular plates sealing the ends of an engine cylinder.

Cylinder head

The part above the cylinder block in an internal combustion engine within which the combustion space is formed and which often carried the valves and spark plugs.

Cylinder hone

A honing tool with two or three stones intended to be worked inside a cylindrical bore.

D

Darby. Abraham,

Inventor of the blast furnace for steel making. His original furnace can still be seen in Ironbridge.

D-bit

A cutting tool which is little more than a cylindrical bar ground away on one side so that little more than half its diameter remains. A cutting clearance is ground on the end. A tool of this kind may be used to size and finish a hole in exactly the same way as a reamer, potentially giving better results if well made. They can be made from HSS stock simply by grinding, or more cheaply from silver steel, in which case they need to be hardened and tempered to straw before being used. The same basic tool design can be adapted to make flat-bottomed holes, round bottomed or tapered holes, simply by changing the shape of the blank.

DC

Direct current. An electrical supply in which the flow of current is always in the same direction.

Dead blow hammer

A hammer with a hollow head, filled with loose ball bearings or made of a soft metal, such as lead. Such a hammer has little tendency to bounce and is used for some forming and metal beating operations where a great deal of control is required.

Dead smooth file

A file with very small teeth giving a fine surface finish, not used for the removal of large quantities of material.

Dead to size

Exactly to nominal size, at least to within practical limits of measurement and machining.

Deburrer

A tool with a hardened tip designed to be scraped along a machined edge to remove any burr and break its arris, leaving a slightly bevelled edge.

Deburring tool

Tools with variously shaped blades (according to the material they are used on) that are drawn along an edge to shave off any burr and leave a small bevel.

Decalescence

A phenomenon whereby steel loses its magnetism when heated past its decalescence point. At a temperature of 700-800˚c carbon steel undergoes a transformation from various magnetic (ferrite, pearlite or martensite) body-centred cubic crystal structures, into non-magnetic austentite, with a face centred cubic structure.

Decarburising

A form of burning of steel in which carbon is lost from its surface, rendering it relatively soft.

Decibel

A unit used for the comparison of the size of signals on a logarithmic scale; a decibel is one tenth of a bel. One bel represents a ten-fold increase in magnitude, and three decibels a two-fold increase.

Decimal fraction

A non-integer number expressed as a value to one or more decimal places.

Dedendum

The depth of the tooth spaces of a gear below the pitch circle.

Deformation

A change in the shape or size of a component. Permanent deformation results from it being stressed beyond its yield point due to the application of external loads. In contrast, changes resulting from the redistribution of stresses within a component due to machining or heat treating are termed distortion.

Degree

1. In angular measure, one three-hundred and sixtieth of a complete rotation. 360 degrees equal 2 x Pi radians.
2. One step on a scale of temperature, the increment it represents being dependent on the scale.

Degrees of freedom

The number of ways a flexible joint or a jointed mechanism can move. For example a milling machine with and X-Y table, vertically adjustable head on a tiltable column and with a rotary table attached has five degrees of freedom. Such considerations become important when machining complex, symmetrical shapes or compound angles.

Dehumidifier

A device working on a similar principle to a refrigerator that extracts water from the air by cooling it.

Density

The ratio of mass to volume for a material. It may be given various obvious combinations of units. Grams per cubic centimetre are particularly convenient, as this gives the same figure as the specific gravity of a material.

Depth gauge

A simple device for measuring the depth of a hole or a step, consisting of a probe that is usually a friction fit in a body with a flat reference surface.

Depth micrometer

A sophisticated device that has a probe, adjusted by means of a micrometer thimble, reaching below a flat reference surface for measuring the depth of a hole or a step. Also used for high-resolution digital devices with a similar purpose.

Depth of cut

The depth of metal removed by a tool at each pass across the work.

Development

Standard three-view drawings do not indicate the true shape of surfaces that are curved, bent or do not lie normal to one of the views. Various techniques can be used to draw out the two-dimensional shape of such surfaces as a development. A development is useful when sheet metal parts have to be prepared prior to folding or rolling to a final shape. An example might be the shape required to form the wall of a bucket or the sides of a box.

De-zincification

The leaching of zinc from brass in contact with hot water, leading to embrittlement. This is why brass should not be used for steam fittings or anything other than very small, low pressure ‘toy’ boilers.

Dial

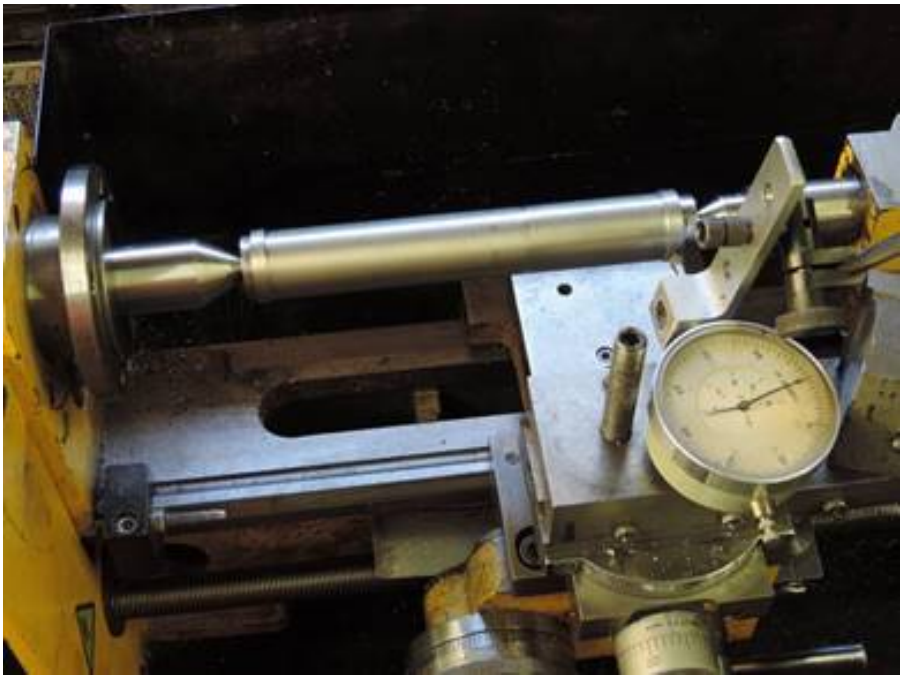
The readout or display of a gauge or measuring device, including the graduated collars that show the movement of a leadscrew or similar.

Dial calliper

A precision calliper that uses a rotary dial for its readout instead of having a vernier scale. Typically reading down to 0.001” (0.2mm).

Dial gauge

A measuring instrument that shows the linear movement of a probe by means of a dial. Typically reading down to 0.0005” (0.01mm) they can be used for absolute measurements by setting a zero mark, but are more usually used to compare the size of two objects. A dial gauge has a larger, more robust probe than a dial test indicator, and it has a linear movement rather than a radial one and a larger range, up to 0.5” (12mm). This also means it is less flexible and unable to reach into small holes.



Dial test indicator (DTI)

A measuring instrument that indicates the angular displacement of a probe at its tip. The range of the instrument is very small, of the order of 0.030” (0.80mm) but it is sensitive, typically reading to 0.0005” (0.01mm). The DTI is not normally used for absolute measurement, but to indicate the truth of a bore or a shaft, the alignment of a flat surface or to sensitively compare the size of two objects. Because of its ability to reach into small bores and work at difficult angles it was greatly preferred over a dial gauge by George Thomas, who used a British made Verdict indicator. Naturally, to accurately measure such small distances the DTI must be securely mounted, something much facilitated by using a magnetic base.

Diameter

The distance from one side of a circle to the other through its centre.

Diametrical Pitch

A method of quoting the pitch of a gear wheel's teeth based on the number of teeth per unit diameter. Normally used for imperial gears, so a 20DP gear with a 1" pitch circle will have 20 teeth, and a 2" one 40 teeth. DP is the inverse of the module of a gear.

Diamond

A crystalline form of carbon, the hardest material known. Industrial diamonds, which do not have the clarity of gemstones, and can be artificially made are used in a variety of forms from large crystals as cutting tools to fine powders as abrasives.

Diamond dresser

An industrial diamond (typically 1/4 to 1 carat) mounted on the end of a metal bar and used to true up grinding wheels. Held rigidly in a suitable holder it is used to restore a fresh, accurate surface to grinding wheels by drawing it across the surface. The diamond is brittle and should only be used to take shaving 'cuts' from the wheel. For bench grinders a simple wheel dresser is more robust if less precise.

Diamond wheel

A grinding wheel with its working surfaces comprising tiny industrial diamonds embedded in a softer matrix. Such wheels can be used to sharpen cutters to a mirror finish.

Die

1. A metal mould used in die casting .
2. A tool used to form external threads, usually slotted on one side to allow them to be adjusted for size. They act largely by cutting, but also to a lesser extent by extrusion in softer metals.
3. A shaped metal template used to form metal under pressure, either by moulding (die casting) or drawing the metal through progressively smaller apertures to shape bar or wire.

Die casting

A casting process that involves the forcing of molten metal into a special mould (die). Typically, metals with relatively low melting points may be used along with steel dies.

Die grinder

A hand held rotary tool used for purposes such as shaping die moulds using burred bits resembling end mills.

Die nut

A thread forming die that cannot be adjusted in size. As they require to be very accurate, they are often more expensive than adjustable dies. Some die nuts are hexagonal, intended for truing damaged threads, turned by a spanner.

Dielectric

An electrical insulator.

Diesel engine

A four stroke compression ignition engine characterised by the injection of fuel directly into the cylinder under high pressure at or near maximum compression. Scale effects mean that it is very difficult (but not impossible) to achieve small capacity diesel engines and the small engines often described as diesels are often two stroke

compression ignition engines using pre-mixed fuel and air.

Diesel outline

A model of a diesel powered prototype locomotive, but powered by some other form of propulsion, typically an electric motor or small petrol engine.

Diestock

A holder for thread forming dies. A diestock has a cavity slightly larger than the nominal size of the dies, and a series of screws around its periphery. One of these is used to centralise the die, on the other side is a cone tipped screw used in the gap of the die to open it out. Adjacent to this screw are two more that engage with dimples or slots in the die to close it up. Because of the need for adjustment, threads are best started with the die slightly opened up, then closed up after a trial until it cuts to size.

Differential expansion

The result of different materials having different co-efficients of thermal expansion. If two items of different materials (such as a copper boiler on a steel chassis) are heated, the differential expansion can cause damaging stresses if they are rigidly fixed to each other at both ends. Similar problems can result from arrangements such as steel link rods fitted to brass or copper structures. Two positive uses of the effect are in thermostats (often using a bimetallic strip) and the temperature compensated pendulum invented by John Harrison.

Differential quenching

The practice of rapidly cooling (and thereby hardening) only part of an object (such as the tip of a tool) by only putting part of it in the quench.

Digital

Literally something you can count on your fingers, meaning in or of numbers. Generally used in contrast to analogue systems which vary continuously to mean systems which vary in discrete steps.

Digital callipers

Are callipers that use electronic sensors, and have a digital display. To read to varying levels of precision. Advantages they have over

traditional callipers include ease of reading and the ability to take differential readings.

Digital display

A device for presenting the reading of a measuring device directly as a sequence of numbers, rather than as a position on a scale. Digital displays are easier to interpret and often have the ability to be set to carry out important tasks that may otherwise introduce errors, such as converting between measurement systems or doubling readings.

Digital readout

See digital display.

Digital vernier

An incorrect term for the digital callipers that are increasingly replacing vernier callipers. A vernier is strictly speaking the graduated scale the digital function replaces.

Disassembly

The process of taking a mechanism apart.

Disc wheel

1. A simple wheel without spokes.
2. A grinding wheel in the form of a flat circular plate.

Displacer

A loose fitting piston, rotor or other device that acts to move the working fluid of hot air engine or similar heat engine between its hot and cold ends.

Distortion

A permanent change in shape or size. Generally used to refer to changes resulting from the redistribution of stresses within a component due to machining or heat treating, rather than due to the application of external loads (deformation).

Dividers

A pivoted two-legged device resembling a compass, but with two hard points. It can be used for transferring measurements and comparing, including between a full size drawing or a rule and a workpiece. The sharp ends can be used to scribe arcs on metal when marking out. Scale dividers have points at each end, they are used for transferring distances in a ratio.

Dividing attachment

A device, often attached to the rear of the mandrel of a lathe that allows a workpiece to be rotated through various angles.

Dividing head

A purpose built angular dividing device that allows a workpiece to be rotated through many different angles or subdivisions of a circle.

Division

The technique of rotating a workpiece through discrete subdivisions of a circle, allowing, for example, an exact number of gear teeth or holes to be made around a circle.

Division plate

A metal plate bearing concentric circles of holes used to assist with indexing a rotary table or dividing head.

Dog

A simple work-holding device with the characteristic feature of having a bit that sticks out and engages (dogs) with something else.

Dog clutch

An all or nothing clutch that provides a positive non-slip drive by engaging shaped mating parts. Typically dog clutches should only be engaged or disengaged when the parts they join are stationary to avoid damaging the clutch with shock loads.

Dolly

A metal support with a hemispherical recess used to support the head of a rivet whilst the other end is being formed.

Doming block

A metal block (usually a cube) with numerous hemispherical depressions on its faces. These can be used to dome metal by beating or pressing sheet metal into them, or the block may be used as a support when bending shafts or other small parts.

Donkey pump

A steam pump that has a common rod joining both drive and pump pistons and no flywheel.

Dot leader

A leader line on a drawing that links a note to a surface or an object. The dot at the end should be drawn on the object, not on an edge.

Double acting reciprocating engine

A piston engine in which the working fluid alternately acts on one side and then the other of the piston.

Double convex file

A file with an oval-shaped cross section.

Double cut file

A file with a second series of teeth cut across the first series.

Double expansion engine

A compound steam engine which expands the steam twice, in a high pressure cylinder and then a larger diameter, low pressure cylinder. These engines make more efficient use of steam, at the expense of complexity.

Dovetail

The commonest arrangement for machine slideways, comprising opposing bearing surfaces inclined inwards. Dovetails may be plain, or more usually include a gib-strip to allow adjustment.

Dovetail cutter

A multi-flute rotary cutter in the form of a truncated cone, used to cut dovetails for machine slides and similar purposes.

Dowel pin

A plain or taper pin that retains parts or keeps them in alignment. It is usual to use two dowel pins for alignment, together with as many screws are needed. The size of the dowels should be similar to that of the other fixings. Normally dowels are a secure fit in one part and the fit in the other is only as tight as is required to ensure adequate accuracy. If parts are to be repeatedly disassembled, then it is sensible to make the pins from hardened and tempered silver steel. Taper pins may be used where greater security or accuracy of fixing is required.

DP

See Diametrical Pitch.

Draft

A slight taper given to the vertical surfaces of a pattern (and hence any resulting castings) in order to facilitate its removal from the mould made from it.

Dragon’s blood

A red resin obtained from the sap of trees of the genus Dracæna used

in some old engineering ‘recipes’.

Drain cock

A tap used to allow liquid to be removed from a vessel. See cylinder cock.

Draw filing

A technique for creating a subtle and smooth ‘brushed’ or ‘ground’ appearance on metal by drawing a file sideways along it. Successful draw filing requires the work to be fixed rigidly, and the file is held at each end and kept level.

Drawbar

A bar used to pull in and secure a tapered tool into the mandrel of a lathe, mill or other machine tool. The is no single standard for drawbar threads sizes, but 3/8” BSF seems to predominate, and 7/16” UNF, M6, M10 and M12 may all be encountered. Fortunately, drawbars are not difficult to make simply by threading both ends of a suitable rod. The use of cheap studding should be avoided, however, as the threads are prone to distort under with repeated use.

Drawing

1. A metal forming process which thins the material by forcing it through or around a die.
2. An American term for increasing the toughness of metal at the expense of its hardness; even in the US the UK term tempering is considered the technically correct term.

Drawn

Used to describe metal bar or wire that has been sized by pulling or drawing it through progressively smaller dies. This process work hardens the material and sets up considerable stresses inside it that can been reduced by heat treatments such as normalising or annealing.

Drift

A bar or punch interposed between a workpiece and a press or even a hammer and used to drive a part into or out of an interference fit.

Drill bit

a rotating toolbit designed to make holes. Less accurate than a reamer, drills can typically produce a hole in a single pass, although see step drilling. For drilling metal most drills have two flutes and a end point at 118°. Each flute has two raised lands to reduce rubbing, and the tip is backed off at the end by grinding to give relief to the cutting edges.

Drill Chuck

A workholding device for securely gripping cylindrical toolbits such as drills, usually with three jaws. A drill chuck is typically only designed to take end loads and should not be used for milling.

Drill chuck arbor

A tapered metal body, designed to fit the mandrel of a machine tool, on which a drill chuck can be mounted.

Drill drift

A hardened steel wedge used to release morse taper shank drills with a driving tang from a socket. Drilling machines with morse taper spindles often have a hole at the base of the socket to allow insertion of the wedge.

Drill gauge

A metal plate pierced with accurate, labelled, holes for identifying the sizes of twist drills (smaller sizes of twist drill do not have their size marked on them). It is difficult to accurately measure drills across their flutes with a micrometer. A drill gauge is more reliable than relying on the holes in a drill box, which tend to be oversize.

Drill grinding attachment

A jig for holding a twist drill for sharpening on a grinding wheel, that ensures the correct cone angle and relief for the point.

Drill pad

A circular pad with a central hole, and often a v-slot across its face, used in the tailstock of a lathe to support work for drilling by a tool held in the headstock.

Drill point angle

The included angle at the working end of a drill bit. In theory every material has an ideal angle, but most drill bits have an angle of 118°. Larger angles can be used for drills meant for use on thin sheet, while more acute angles are used for spotting drills and countersinks.

Drill rod

Accurately ground carbon-steel bar, easily hardened and suitable for making small tools and other accurately sized and durable parts. It is the US equivalent of silver steel, although it does not contain chromium which is added to the latter to reduce distortion on hardening.

Drill stand

A metal or wooden storage device with, multiple holes of various sizes that provides a way of storing drill bits and sorting them by size.

Drill vice

A machine vice designed for use with a drill press. As the action of a drill is to push the work downwards, drill vices tend to be of less robust construction than milling vices and to have less resistance to jaw lift. Even fairly basic drill vices can be adapted for light milling with a little work (to remove slop and improve the accuracy of sliding surfaces), but should not be relied on for heavy cuts. For all but the smallest holes a drill vice should be securely fixed to the machine table.

Drilling

The making of holes by forcing a rotating cutter into the work. Drills are made to cut on the end, not the flutes. The modern type of drill bit is the two-flute type,

Drilling lubricants

When drilling most materials some form of lubricant greatly reduces the pressure required, increases drill bit life and eases the passage of swarf from the drilled hole. Both soluble oil and neat cutting oil are effective for most materials. For aluminium and hard spots in steel or cast iron paraffin can be an effective lubricant.

Drilling machine

A device for the production of holes by drilling. Typically comprising a balanced head containing a multi-speed spindle over a moveable work table. Drill bits are usually held in a chuck on the spindle, which is fitted to a quill which can be advances to force the bit into the work.

Drive belt

A continuous flexible loop of material used to transmit power between pulleys mounted on two or more shafts. Light loads are conveniently transmitted by light round or v-shaped belts, in the past of rubber, cotton or leather but now often of various polymers. These modern materials tend to be easier to maintain, but less forgiving of changes

in tension or pulley separation. Historically flat belts (often of leather) or multiple cotton ropes were used to carry moderate to high loads, but now reinforced toothed rubber or poly-vee belts are used.

Drive fit

See press fit.

DRO

Digital Read Out. Often used as shorthand for an electronic position sensor with a digital display.

Dry steam

See superheated steam.

DTI

Dial Test Indicator.

Ductility

The readiness of a material to change its shape under stress; to be drawn out into a wire or bend. Very ductile materials will flow into a new shape (though they may be subject to work hardening, resulting in a loss of ductility).

Duplex

1. Double acting, a reciprocating device which works on both directions of its stroke.
2. Pen name used by two co-writers (Ian Bradley and Norman Hallows) for Model Engineer whose specialism was workshop devices and techniques.

Duty

An assessment of the nature and frequency of the load a machine is expected to handle (e.g. Heavy duty, light duty, interrupted duty).

Duty cycle

The relative ratio a device spends working to lying idle, a lower duty cycle implies a need for less robustness being needed to achieve long life. Hobby machines typically expect a lower duty cycle compared to

those in a busy factory. Important for electrical motors, especially certain types which may be able to sustain a limited number of starts per hour without overheating. An interesting contrast is between an industrial drilling machine whose motor may run virtually non-stop all day, and a typical power drill which may only operate for hours over a lifetime of years.

Dynamic equilibrium

A stable situation where a substance or object is passing back and forth between two states, but at equal rates in each direction.

Dynamo

A moving coil electrical generator that produces direct current electricity.

E

E.T.W.

See Westbury. Edgar T.

Earth

Earth is an additional conductor found in most mains electrical installations. It's purpose is to ensure that in the event of a fault rendering exposed metal parts of a machine live, a high fault current is generated that immediately causes the fuse to blow or protective circuit breakers to trip.

Easy running fit

See free running fit.

Ebony

A dense, hard, black wood originating from certain African trees. It is a stable material suitable for engineering applications, such as bearings in clocks.

Eccentric

Rotating around a point which is not the geometric centre of an object.

A circular device used to impart a reciprocating motion to a device, such as the valve of a steam engine. In contrast to a cam, which can only push, an eccentric is usually fitted with a strap allowing it to both pull and push.

Eddy currents

Localised electrical flow within a metal object in a changing electromagnetic field. Eddy currents can cause significant losses in the armatures of motors and transformers, which is why they are usually made from a series of insulated laminations.

Edge detection

When setting up to mill or drill work by jig boring methods it is helpful to be able to accurately position the edges of the work. Methods for doing this range from electronic edge finders, through mechanical edge finders to the simple cigarette paper.

Edge finder

A device that fits a milling machine, with a precisely dimensioned cylinder or ball at the tip of a probe. The probe tip initially rotates off centre, but when the tip contacts a workpiece it gradually gets pushed so that it rotates truly. Once the tip is pushed slightly past the dead true point, it runs along the side of the work. The centre of the mandrel is now half the tip's diameter from the edge of the work, typically to within less than a thou (0.02mm).

Efficiency

The effectiveness of a system at converting energy from one form into another calculated as the amount of useful work dome by a system compared to that put into the system. The efficiency of some systems is remarkably poor. Efficiencies of 2-3% for model steam locomotives are regarded as high, for example. As a general rule, most of the wasted energy will be lost as heat or other forms of vibrational energy (sound for example).

Elastic limit

The maximum stress that may be placed on a material without causing permanent deformation, iIn other words the amount it may be stretched or bent while still being able to return to its original shape. For steel the elastic limit is essentially its proportional limit, but this is not true of most materials. It cannot be assumed that a material can be continually stretched to its elastic limit without ill-effects, or even by considerably greater amounts because of the effects of fatigue. Some materials do not have an elastic region and will show a small amount of permanent deformation even from small stresses.

Elastic region

Is used to describe stresses on a material that do not take it beyond its elastic limit, they do not cause any permanent deformation. For example, a suspension spring must be operated in its elastic region, as taking it beyond its elastic limit will change its shape and change its properties. Some materials do not have an elastic region and will show a small amount of permanent distortion even from small stresses.

Elasticity

The resistance of a material to deformation under compression or tension.

Elastomer

A synthetic polymer with elastic properties, suiting it for use as combined springs and shock absorbers.

Elastomeric Adhesive

Flexible adhesives with good elastic properties, suitable for joining flexible materials.

Electric motor

A device used for the conversion of electrical energy to movement. Most hobby machine tools use single phase motors or three phase motors with an inverter.

Electricity

The property of matter that reflects the behaviour of charged particles and objects.

Electromagnetic

Operated by the principles of electricity and magnetism.

Electron

A fundamental particle carrying a single negative charge. Chemical reactions are essentially the end result of atoms and ions swapping or sharing electrons.

Electronic edge finder

A type of edge finder that fits in the mandrel of a milling machine, with a precisely centred and dimensioned sprung ball at its tip. When the ball contacts a workpiece it completes a circuit and lights a lamp or makes a sound; the centre of the mandrel is now half the ball's diameter from the edge of the work.

Electroplating

A process for depositing a layer of metal on a conductive object by immersing it in a solution of the plating metal and passing a current though it.

Electro-pneumatic contactors

Special relays which use a pilot solenoid to control a hydraulic switch. They allow very small currents to control very large currents and can be very fast. Typically used to control large electric traction motors.

Elements

Chemicals that comprise just atoms of the same atomic number.

Elevation

An engineering drawing of an object viewing one of its vertical faces (front, back or sides). A view from above is a plan.

Ellipse

A shape related to a circle but stretched on one axis.

Elliptical

Having the form of an ellipse.

Elm

A strong timber with excellent resistance to rotting and splitting, even in situations where it permanently wet. Once available in huge sections it was sometimes used as a foundation for heavy machine tools, but since Dutch Elm Disease in the 1970s it is rarely found as a timber tree.

Elongation

The amount by which something extends when subject to tension.

Embrittlement

The reduction of a metal’s ductility, increasing its vulnerability to stress fractures. A particular risk where brass is used in association with pressure vessels du to de-zincification.

Emery

A natural abrasive, mostly aluminium oxide with other minerals, including iron spinel, that give it a red colour. It is usually supplied in the form of cloth backed sheets or strips and sometimes coated paper or strips of cardboard. Emery is an effective abrasive for polishing and finishing metal, although it has partly been replaced by carborundum-based abrasives.

EN specification

Emergency Numbers were used to standardise the composition of various steels during the Second World War.

EN1A

The EN specification for a readily available and free-cutting sulphur bearing mild steel, now officially known as 220M07 but perhaps still more easily obtained as EN1A. It is often referred to in constructional articles on account of being easy to work and machine to a good finish. It gives off a faint, but distinct, smell of sulphur when machined. EN1APb contains additional lead and is exceptionally free cutting.

End mill

A multi-flute cutter designed for cutting along its edge; that is along the end or side of a workpiece. Generally, end mills are not designed to be plunged into the work or to cut accurate slots and a slot drill should be used for these purposes instead.

Endurance limit

The expected number of cycles of a given stress that a component can take before failure due to fatigue.

Energy

Defined as the capacity to do work, energy can exist in many forms, such as potential, kinetic, chemical, electrical and heat energy.

Engine

A device that allows energy in one form or another to do useful work.

Engineer –One who works with or designs engines; one who practices one or more of the many branches of engineering. Some professionals argue that an engineer is one who is qualified in a technical subject and that amateurs should not use the term for themselves.

Engineering in Miniature

A monthly UK model engineering magazine.

Engineers square

A measuring tool for gauging or marking out right angles. The truth of a square can be tested by using it to mark a perpendicular against a

straight edge, then reversing it.

Englander

German term for an adjustable wrench.

English pattern toolpost

A four-way toolpost.

English projection

An old term for first angle projection.

Engraver

A machine used for engraving.

Engraving

The marking of materials using a sharp rotating or reciprocating toolbit.

Engraving cutter

Cutters for engraving usually have very fine, bevelled points, designed to be worked at very high speeds. As with all types of cutter the exact specification will depend on the material to be worked.

Epoxy adhesive

Two part adhesives based on epoxy resins. Epoxy adhesives may be obtained in various formulations usually distinguished by their setting time

From a few minutes to twenty-four hours. The longer the setting time the stronger the bond. Setting time may be decreased by gently heating the resin. This also makes the resin more fluid (for a short time) which can be useful.

Epoxy putty

A putty in two parts comprising filler material loaded with epoxy resin and hardener. On kneading equal amounts of the two constituents together the putty hardens. The resulting material is resistant to most acids an alkalis and modest heat. It may be drilled, tapped and sanded like a soft metal, though its strength is not great. It is particularly

suitable for making small parts that resemble moulded items, and has the advantage over many other fillers in that it will keep any shape it is moulded into until it is set.

Epoxy resin

A high molecular weight synthetic resin that cures on addition of a suitable hardener. Most often encountered as two part adhesives, but also used in many fibre-reinforced composites. Epoxies are also used as a basis of other two-part products including epoxy putty and two-pack paint. The high molecular weight compounds can enter the skin and may cause sensitivity or irritation with regular exposure. The use of barrier cream is recommended.

Equation of time

An irregular but smooth curve that plots the deviation of the time indicated by a sundial (solar time) from the true time (celestial time). The deviation arises largely from the way shape of the earth's orbit deviates from a circle.

Equilateral

With all sides equal, as with a regular polygon such as a square.

Equilateral triangle

A triangle with all its sides the same length and hence has all angles equal to 60°.

Equilibrium

In a state of rest condition. An object in a stable equilibrium will tend to return to its original position if slightly displaced (for example at the bottom of a dish), an object in unstable equilibrium will not (for example, balanced on a hilltop).

ER Collet System

A collet system suitable for holding both materials and milling cutters. Available in several series according to size, all but the smallest bore collets operate over an extended range (hence 'ER'), offering a significant advantage over most systems that may require vary many collets to cover a full range of sizes.

Erosion

The wearing away of a material by mechanical abrasion, chemical action or electrical discharge.

Escapement

A precision ratchet that acts together with a pendulum, balance wheel or other timing device to allow the gradual turning of a clockwork mechanism, whilst also providing gentle impulses to keep the timing component in motion.

Etching

A chemical process for shaping metal, using a suitable chemical (etchant) such as ferric chloride for brass and copper. The object to be etched is masked in some way to allow precise and complex shapes to be etched.

Etch primer

A primer that gently attacks the surface of metal it is painted onto, allowing it to attach more securely to difficult surfaces such as brass.

Eutectic

A mixture of substances in proportions such that it passes between solid and liquid phases at a single defined temperature. Non-eutectic mixtures have a solidus and a liquidus and between their temperatures consist of a more or less mushy mix of solid and liquid.

Eutectic alloy

When molten metal cools slowly the different constituent metals may crystallise out at different rates depending on their concentration and individual properties. This changes their concentrations until the molten metal reaches a stable or eutectic composition. Typically eutectic metal alloys are very fluid when molten and have a well defined melting point. Non-eutectic alloys tend to have a melting range and may become pasty rather than fluid. Makers of hard and soft solders use these differences to create filler metals with varying properties. For example, eutectic solders flow well and can be used to fill thin joints by capillary action. A non-eutectic solder may be more suitable when it is desired to build a well defined fillet up along a

joint.

Eutectic steel (eutectoid steel)

A carbon steel with exactly 0.85% carbon content. Such a steel transforms directly between austentite and pearlite on heating and cooling past its critical temperature, assuming the rate of cooling is not too rapid, and hence contains neither ferrite nor cementite. In the annealed state, steels with less carbon are termed hypo-eutectic and contain ferrite and are therefore softer than those with more carbon which contain hard cementite.

Evans. Martin,

The designer of many popular small locomotives, including Simplex and Rob Roy, former editor of Model Engineer and instigator of IMLEC.

Exhaust

1. The waste gases from an engine.
2. The passage these gases follow.

Expand

To allow the volume or size of an object to increase, such as gas within a cylinder or a spring. Expansion allows the energy stored within a compressed system to be recovered.

Expansion link

An intermediate link in many types of steam engine valve gears that allows the valve travel to be ‘notched up’ allowing a greater degree of expansive working.

Expansion spring

A tension spring

Expansive working

If the steam supply to a steam engine cylinder is cut off before it fills the cylinder, it will continue to expand, cooling as it does so. This expansion extracts more energy from the steam and is therefore a more efficient way of working.

External combustion engines

Those in which the fuel is burnt outside the engine, heating a separate working fluid. The obvious example is a steam engine, in which various fuels may be burned to boil water and produce steam.

External taper

Then end of a shaft or tool accurately machined as part of a cone to fit with a matching internal taper. See also taper.

External thread

A thread around the outside of a circular part, as in a screw or bolt.

Eye splice

A technique for making an eye at the end of a rope or cable by turning it back on itself to create a loop.

Eyebolt

A threaded fixing with a circular head for the attachment of hooks or ropes.

F

Fabrication

The building up of a complex part from multiple components, often used as an alternative to using a casting. The parts may be held together in various ways, such as adhesives, brazing and threaded fixings, usually with the aim of creating as rigid a structure as possible.

Face

A flat surface on an object, for example a cube has six faces.

Faceplate

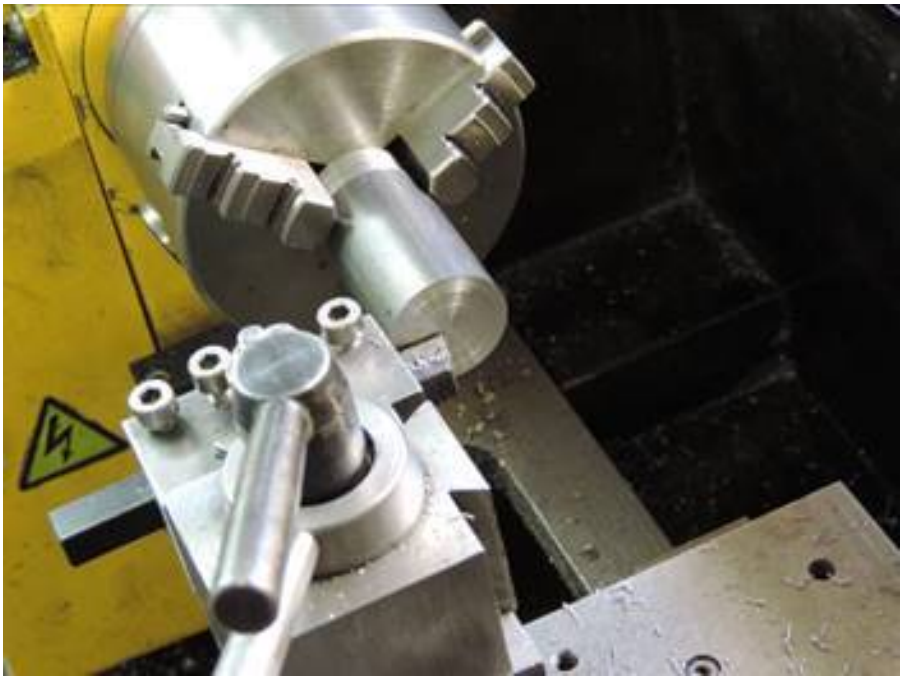
A flat disc of metal which may be attached to the end of a lathe's mandrel. Faceplates have either open slots or t-slots or may be drilled and tapped so that a workpiece may be attached by any sensible arrangement of fixings. Some faceplates are completely plain, and may be used as a glue chuck by the use of turner's cement.

Facet

A face or flat side of an object. Usually used to describe multiple flat surfaces regularly arranged around an object, as the facets of a cut diamond.

Facing

A procedure in turning that involves moving the tool across the lathe axis to generate a flat surface, as on the end of a cylinder.



Fail safe

A system designed to adopt a safe configuration in the event of a fault. Examples are no voltage release switches and vacuum brakes.

False nose

A pointed metal attachment fitted to the end of the screwed shaft of a grinding machine, to allow the fitting of polishing mops.

Fast and loose pulleys

A pair of pulleys on the input shaft of a machine tool driven by a belt from an overhead layshaft, the normal arrangement before the days of individual electrical motors powering machine tools. Fast is used in the sense of ‘fastened’ and when the belt runs over the fast pulley it drives the machine, when it travels over the loose pulley the machine is left unpowered. Skilled operators could delicately ‘inch’ a machine by careful manipulation of the belt.

Fastener

Any of a plethora of devices used for the permanent or temporary joining of two or more parts. They may be threaded such as screws, bolts, nuts and studs; rely on force fits such as roll pins, taper pins; be

sprung such as circlips for example.

Fatigue

The effect of repeated cycles of stress reversal, loading and unloading of a component. It may be caused by many mechanisms such as the propagation of tiny cracks, or changes in the crystal structure similar to work hardening leading to brittleness. Generally the higher the applied stress the shorter the time to failure, but failure may still occur when the applied stress is far below the yield point of the material. It is hard for model engineers to calculate or research the endurance limits of their components, and it is generally best to ensure that regularly stressed components are made of tough materials, have adequate cross-sections and are shaped to avoid the build up of local stresses. While a few very skilled model engineers have demonstrated that it is possible to make many delicate working parts of their models to true scale, the endurance limits of such parts may not be sufficient to allow a reasonable working life.

FC3 end mill

A series of small, relatively inexpensive cutter made to tight tolerances. They are ideal for many model engineering purposes because their geometry allows them to be used both as end mills and as slot drills. They are available in imperial msizes to 1/4” and metric sizes to 6mm, in both square ended and ball ended styles. Despite the name of ‘throwaway cutters’ they can be resharpened on the ends with relative ease.

FCMS

Free Cutting Mild Steel.

Feed rate

The speed at which a tool is moved past the work. The feed rate multiplied by the tooth load (or depth of cut for a single point tool) defines the size of chip produced by a machining operation. If work or a cutter is rotated faster it is usual to increase the feedrate to keep the tool cutting. Normally in quoted in inches or mm per minute.

Feeler gauge

A flat leaf of hardened steel shim used for assessing the size of small gaps, usually supplied in the form of a set of such gauges fitted in a

handle. A familiar use for such gauges is checking the gap of spark plugs. In use one or more blades are inserted in a gap, an accurate fit being when there is just slight resistance felt to the movement of the blade(s) in the gap.

Fence

A straight guide used to help control the path of a workpiece past a cutting tool.

Ferrite

A near-pure form of iron, containing little carbon, with a Brinell hardness of around 90. Wrought iron is almost pure ferrite, and mild steel is ferrite mixed with pearlite (itself a mixture of hard cementite and soft ferrite).

Fettling

The art of cleaning moulding sand, flash and other extraneuos material from raw castings. Unfortunately, the delicate nature of many model-sized castings renders them vulnerable to the loss of detail or sharp edges if fettled by standard foundry techniques, such as the use of rotary brushes or belt linishers. Careful hand fettling using files should aim to preserve detail and an ‘as cast’ appearance, whilst removing any over-scale casting defects.

FHP

Fractional horsepower, used to describe small electrical motors with powers of less than 1 horsepower (0.75 kw).

Fibre

A material in the form of filaments, or a composite material largely made of such fibres in a matrix such as a fibre washer.

Fibre gasket

A sealing gasket reinforced with strong fibres. In the past asbestos fibres were often used, but various modern alternatives are available.

Fibre washer

A reinforced but compliant washer often used for low pressure sealing purposes.

Fibreglass

1. Fine filaments of glass produced by extrusion of the molten material.
2. A frequently used but technically incorrect term for glass reinforced plastic a composite made using fibreglass.

Field winding

Coils in an electrical motor or generator that create a static magnetic field in which the rotor moves. Controlling the (smaller) current in the field winding is a convenient method of motor control in some circumstances. Typically, a generator with field windings will rely on small amounts of residual magnetism in order to produce the initial current that charges the windings.

Files

Hand tools with flat or curved surfaces bearing many teeth for the removal of metal. Files come in various grades or cuts, from dead smooth through smooth and medium to bastard. Most files are made of carbon steel, but files with diamond or carbide particles bonded to their surface are increasingly common.

Filing

The art of efficient and accurate metal removal using files. Good filing technique is an invaluable asset, and in the past, a traditional first duty for any apprentice was to take an irregular lump of metal and file it into some precision shape. For large files, the best technique is to hold the workpiece in a vice, at elbow height.

Filing buttons

Simple round, drilled jigs that can be fixed either side of a hole to guide that hand filling of a curve concentric to the hole. Hardened filing buttons last longer, but it is considered that they may cause damage file teeth. Soft buttons are most effective when they are able to rotate.

Filing rest

A height adjustable jig with two rollers used to support a file when using it to put accurate flats on an object held in a lathe.

Filings

Waste metal in the form of tiny particles or powder as produced by a file or machining cast iron, in contrast to granular or curled swarf. Cast iron filings can be particularly damaging as they are small enough to get trapped between moving parts and when mixed with oil can form an abrasive paste.

Filler metal

Additional metal introduced to fill gaps, create fillets and form a joint between two surfaces during brazing, soldering or welding.

Fillet

A triangular or curved wedge that fills the angle between two surfaces; it may be material left after machining, cast in or the result of using extra filler material in welding or brazing. Sharp joints between surfaces can act as stress raisers and are points of weakness, even small fillets can reduce such stresses greatly. On models, artificial fillets are often added to fabricated components to disguise them as castings.

Fine feed

Applying a cut to a workpiece using a low feedrate, facilitating a good, accurate finish. Most lathes have provision for fine feed under self-act but with skill and patience, a fine feed can be applied by hand.

Finger pressure

A subjective term used to describe the degree of force that can be applied by the fingers (rather than the whole hand) without the use of tools.

Finish

See surface finish.

Finish turning

The final machining operations on a piece of work aimed to bring it dead to size and/or to a high finish.

Fire welding

The joining of metals by heating them until they become plastic and then joining them by physically beating them together.

Firebox

The cavity that forms the part of a boiler where the combustion of fuel takes place. In most locomotive boilers the firebox is largely surrounded by water.

Firebrick

Ceramic bricks with strong refactory properties. They are used for purposes such as lining furnaces or hearths.

Firetubes

Tubes in a boiler that carry the combustion products from the firebox to the smokebox or flue.

First angle projection

A three view drawing in which adjacent view is placed as if the object has been rotated through 90°. If the first view is from the front, a top view will lie below it and the right hand view will lie on its left, and vice versa. This is the favoured projection in the UK, though it can be argued that third angle projection is easier to read as each view lies where it might be expected (top above the front view, etc.) It is normal to indicate this projection with a small two-view drawing of a truncated cone according to the projection, i.e. Two concentric circles adjacent to the large end of the cone

Fit

The ease with which two parts will mate with each other, typically a shaft in a mating hole. Typically the hole is made dead to size and the shaft size varied to provide the correct fit (but not always, as when using precision ground bar for a shaft). Starting with the loosest fits these include: clearance fits; running fits; slide fits, push fits; keying fits; drive; force fits and shrink fits. Although there are detailed and complex ways of specifying fits by toleranced sizes, in model engineering it is usually more usual to specify a fit by the action required. Many model designs leave this to the constructor's interpretation of the requirements, for example it can generally be assumed that a shaft in a bearing needs a running fit.

Fitted bolt

A bolt that has part of its shank left unthreaded and sized to be a good fit in the parts it passes through.

Fixed Steady

A steady rest that is attached to the lathe bed, rather than the saddle.

Fixing

A device for attaching two or more objects together on a more or less permanent basis, a fastener. Examples include screws, bolts, nuts and rivets.

Fixture

A contrivance that allows an awkward object to be held securely for machining.

Flame annealing

The softening of localised areas of a hard metal part by the use of a high-temperature flame. This is a useful technique for softening the shanks of silver steel tools that have been annealed in an oil bath (chip pan) or oven. For small tools, that have an edge that needs to be kept hard, one technique is to embed the edge in a potato while running a flame over the shank of the tool.

Flame hardening

The hardening of localised parts of the surface of a steel or cast iron component by heating with a fierce flame, followed by rapid quenching.

Flange

A projecting rim around a part used for attaching it. The usual full-size practice for joining pipes carrying steam or compressed air is to use flanges, not unions. Normally the number of holes in a flange is a multiple of four, to allow joints to be easily aligned horizontally or vertically. Any pair of fanges may need sealing with a gasket or an o-ring.

Flat

1. A surface with all points lying in the same plane. The act of making a surface so.
2. A reference surface that is flat to an extreme level of accuracy (such as an optical flat).
3. Of metal stock, with a cross section that is thin in comparison to its width.
4. Not shiny, matt (Amer.)

Flat drill

A spade drill.

Flue

A passageway for the hot gases produced in a furnace or fire; such as in a boiler or a forge. A long vertical flue creates a strong draught and helps to pull fresh air into the base of a fire.

Fluid

A substance in a form in which it can flow; a liquid, gas or vapour.

Flute

A longitudinal groove, often rounded in cross section. Most rotating cutting tools are fluted (either in a slow spiral, or parallel to the length of the tool) to provide both cutting angles and provide a space for chip formation. Flutes may be applied as a decoration to classical-style columns and other machine parts, or to reduce reciprocating weight, as in connecting rods. Typically, locomotive connecting rods are fluted on both sides, using cutters with slightly rounded corners but not always.

Fluted drill

Drills (usually in very small sizes) with two straight flutes; twist drills also have flutes, but this term is used to denote those with straight flutes. In small sizes they are stronger than twist drills, but do not clear swarf so readily.

Flux

A substance used to clean a surface to be soldered or brazed, and keep it free from oxides during heating. On heating fluxes melt and form a

liquid shield over the work, active fluxes reduce oxides and may have a limited lifetime at their working temperature. Many types of flux are available, but there are three main types. Those for soft soldering can be subdivided into passive fluxes, like rosin, and active fluxes like baker's fluid. Silver soldering fluxes are all active and are subdivided into the 'easyflo' types, and the 'tenacity' types for higher temperatures and stainless steel. Finally, for brazing the usual flux is plain borax powder.

Flycutter

A single-point tool that works at an appreciable radius and is used for the production of flat surfaces. Their main advantage is that they can be set to sweep the whole of a surface, and when used with a fine feed a very good finish can result, however, they are often slow compared to end mills.

Flywheel

A heavy wheel fitted to a shaft that stores and gives up rotational energy in order to smooth out irregularities in the supply of power to a shaft. Without a flywheel many engines would run poorly or not at all as they would stop or slow at points in their cycle when no power is applied to the shaft.

Follower

A lever that follows the outline of a cam. In internal combustion engines followers transfer the motion of an overhead camshaft to the ends of the valves of an engine. While a direct acting camshaft is often used in small engines, in larger engine the use of followers facilitates the adjustment of the valve gap by moving the pivot point of the follower.

Foot

An imperial measure of distance, twelve inches or a third if a yard. Rarely used in engineering where the inch is preferred for most purposes.

Foot-pound

A unit of torque that is literally the effect of pulling the end of a foot long lever with a force of one pound.

Force

An agent through which matter interacts. For engineering purposes we may be looking at pushing or pulling forces in mechanisms such as pressure in a boiler or the load on a lever.

Force fit

A class of fit where two mating parts require a significant degree of force (usually from a press or some other tool) to be applied in order to join them. An example might be a gearwheel on its shaft. It is hard to disassemble force fits without damaging either part and the careful use of an appropriate tool is normally required. For a 1” (25mm) diameter shaft in a dead-size hole the shaft should be 0.00125” (0.03 mm) oversize.

Forced lubrication

An oil distribution system that depends on a pump.

Forge

1. A workshop (and also the hearth within it) typically also equipped with anvil, vices, hammers and an array of other tools for the working of hot metal by hand.
2. The act of shaping metal by hand.

Forging

The art of working of metal which has been heated, to allow it to be shaped easily. Some metal may be successfully cold-worked but a blacksmith is an expert in the hot-forging of steel and iron at a red heat. It is not necessary to be equipped with a blacksmith’s forge and anvil to make use of this technique. If a bend is needed in an iron or steel bar, or the end of such a bar needs to be thickened or flattened it can be heated in a flame and worked in a vice or on a block of scrap iron with heavy duty pliers or a hammer.

Form cutter

A form tool.

Form relief

The slight taper behind the cutting edge of a form tool, to promote a free cutting action.

Form tool

Single or multi-point rotating tool designed to cut a specific profile when plunged into the workpiece. Examples are bull-nose cutters, gear cutters and dovetail cutters. The extended cutting edges of such tools mean long lengths of cut, so form tools are vulnerable to chatter and should be used in as rigid a set up as possible, at low speeds and with adequate lubrication.

Former

A metal or wooden template around which annealed metal can be shaped.

Forming

The action of closing a rivet by shaping its plain end with a hammer or a special rivet punch.

Foundrywork

The working of hot or molten metal, in particular the casting of metal.

Four-facet drill point

An alternative to the usual method of sharpening a drill point. The latter involves grinding conical relief behind the cutting edges, but a four facet point has requires flat surfaces to be ground. The four-facet point therefore requires the drill to be set twice, instead of once, but the movement for grinding is simpler. Many argue it is easier to achieve the best results using the four-facet technique. Four facet drills start better and cut more freely than conically ground drills. The largest drills may be ground with six facets.

Four-jaw (chuck)

If used without qualification, a four-jawed independent chuck.

Four-stroke (engine)

An internal combustion engine that fires once every two rotations of the crankshaft. The four strokes are induction, compression, ignition/ expansion and exhaust, or more succinctly suck, squeeze, bang, blow. Typically, such engines require fairly complex valve gear geared to the crankshaft.

Four-way toolpost

A square toolpost, often used on British lathes allowing four tools to be held at once so that they can be rotated into position.. Usually packing is needed to get tools to the correct height. In practice, it is usually impractical for more than two or three tools to be fitted at any one time.

Fractionation

A distillation process in the refining of petroleum products from crude oil, following cracking. After gases butane and pentane, the first liquid fraction is gasoline (petrol), followed by kerosene (paraffin) and then progressively heavier fractions such as waxes and bitumen.

Frame

1. The structural parts of a device that give it strength and locate its working parts.
2. The parallel metal members that comprise the longitudinal members of a locomotives chassis. Most model (and full size) locomotives are made with frames of steel plate.

Frames

The outer parts of the chassis of a locomotive. Most UK locomotives have plate frames, whilst North American ones often have bar frames.

Free cutting

The optimum conditions for removing material when machining. Free cutting depends on using a well made tool, correctly presented to the work at an appropriate cutting speed and feed rate, as well as the properties of the material itself.

Free cutting mild steel

Mild steel with small amounts of added phosphorus, sulphur and sometimes lead, to promote the formation of smaller chips of swarf and facilitate a better surface finish. Free cutting mild steel is readily available in a wide range of imperial and metric sizes in square, rectangular, flat, round and hexagonal cross section.

Free hobbing

The making of worm wheels and other gears with the use of a spiral toothed hob. If a spiral hob is gradually fed into a suitably sized blank mounted on mandrel that is free to rotate, it will spin the blank and cut a full gear. To make a standard gear the hob must be set over at its helix angle and moved across the face of the gear during cutting. It is advantageous to use a free-cutting material for the gear blank and to gash it in advance.

Free play

The amount of movement in a bearing, linkage or similar arrangement. Free play may allow movement with minimal friction, allow differential expansion or prevent small movements of one part affecting the setting of another. Generally free play is deliberately introduced, unlike lost motion.

Free running fit

A class of fit that allows a shaft or pivot to rotate easily with minimal friction and tolerating minor misalignment, such as an axle in its bearing. For a 1” (25mm) diameter shaft in a dead-size hole the shaft might typically be 0.004” (0.10mm) undersize.

Freelance

A model not based on a particular prototype, but still built according to the general proportions and conventions of full size practice. Reasons for adopting a freelance design may range from simplifying construction in various ways (such as using stock material sizes or avoiding particularly difficult elements) to the pleasure of building something entirely to one’s own design. Some freelance designs have become classics in there own right, such as LBSC’s Ayesha and Martin Evan’s Simplex.

Fretsaw

A light duty hand or machine saw with a narrow fine-toothed blade that can be used for the cutting out of complex shapes and curves, including internal corners.

Fretting corrosion

The oxidation of metals at a point where they are subject to repeated rubbing. Fretting corrosion can cause parts to seize in place unexpectedly.

Friction

The resistance of two surfaces to moving against each other. It is proportional (at low pressures) to the force holding the two surfaces together and their coefficient of friction. An important result of this is that the area of a bearing’s surface is not significant in reducing or increasing friction, as long as the bearing is not overloaded. Friction is constant at low speeds, but decreases at higher speeds. The work done in overcoming friction is dissipated as heat in the bearing surfaces. Friction can be reduced by the careful choice of bearing materials and the use of lubrication.

Front rake

The relief, usually about 7-10 degrees, on the front of lathe tool to stop it rubbing against the work and promote free cutting.

Frustrum

The tip of a cone.

Full nut

A standard sized general purpose nut, in contrast to a half-nut.

Furnace

A structure for concentrating heat in order to melt or heat treat metals.

Fuse

1. A device that limits current by melting or vaporising in an over-current situation. Quick blow fuses will blow very rapidly when current exceeds their nominal value. Time delay fuses contain a thermal buffer in the from of a metal bead or spring and require the over-current situation to continue for longer; they are usually used for equipment such as motors which may have brief high-current requirements when switched on.
2. To change a solid material into a liquid state by heating; to melt it.
3. To combine two materials or objects by melting, for example as happens in welding.

Fusible plug

A safety device for boilers comprising a hollow metal plug fitted to the firebox crown and filled with an alloy with a low melting point. In the event that the water level falls below the crown and it overheats, the plug melts and the fire is doused with steam. It is not an alternative to a safety valve or proper supervision of a boiler.

G

G

The acceleration due to gravity at the surface of the earth. It is close to the value of 32.2 fts-2 (9.81 ms-2).

Galvanising

The coating of steel components with zinc, originally by electrolosis (i.e. Galvanic or electrical action), but now also used to refer top a hot-dip process. Due to the typically poor surface finish it is rarely used by model engineers.

Gap bed lathe

A lathe on which the shears do not extend all the way to the headstock, there being instead a gap allowing work of significantly greater diameter than normal (but limited length) to be turned. Some lathes have a removable gap-piece that may be fixed into the gap. It is good practice to keep the gap-piece fitted as the default set up of the lathe, to ensure even wear.

Gas

A state of matter; an elastic fluid able to expand to fill its container completely.

Gas constant

A constant (proportional to the molecular weight of a gas) that allows its properties to be predicted using the gas law.

Gas law

The product of the pressure and temperature of a gas is proportional to its volume and mass. This can be rearranged as formula with the addition of the gas constant. Boyle's law is a special case of the gas law when a system remains at a constant temperature (isothermal) in contrast to not losing or gaining heat (adiabatic). In reality, virtually all systems lie between these two ideals, and if calculations in this area are to be undertaken reference to a more detailed work is advised.

Gas turbine

A turbine based internal combustion engine whose working fluid comprises the combustion products of fuel burnt within the engine itself. Where the turbine only generates enough power to compress its charge of air and does work by ejecting a stream of expanding gas it is classed as a turbojet. Other gas turbines may power generators, turn propellers (turboprop) or even drive wheels through a suitable gearbox. In principle a gas turbine only has one moving part, but in practice they are highly complex.

Gashing

The process of roughing out a gear blank with crude slits to reduce the work required to form the teeth, and also to help ensure regular tooth spacing when free hobbing.

Gasket

A thin sheet of a compliant material used to seal a joint between the faces of two components. For oil and steam tight joints at modest pressures and temperatures card and even paper gaskets are adequate. Since the phasing out of asbestos a useful alternative for more demanding duties is klingerite.

Gasoline

See petrol.

Gate valve

A valve that shuts off the flow of fluid by closing a barrier (the gate) across the flow. It has the advantage that when open there is minimal obstruction to the flow, but at high pressures they are prone to jamming.

Gauge

A measuring device that is used as a comparator, rather than giving an absolute measurement. A gauge may simply be set to some arbitrary size, or it may be of a very precise size.

Gauge blocks

A set of precision ground and hardened metal blocks of great accuracy

that may be used individually, or combined in stacks, as comparators for the measurement of precise distances. The surface finish of gauge blocks is such that they will normally wring together and remain in place by molecular adhesion. Also known as Johanssen gauges.

Gauge blue

A non-drying, intense blue paste capable of being spread very thinly. When one surface is blued in this way and rubbed gently on a matching surface the blue will transfer only at the points of contact between them. In this way excess material can be removed. It is not to be confused with marking blue.

Gauge paste

Gauge blue.

Gauge plate

An oil-hardening high-carbon steel that is available as precision ground flats. It can be used for making form tools. It is also ideal for the making of small flat parts that need to be wear resistant such as elements of locomotive valve gear. The precise hardening requirements of gauge plate vary by manufacturer, but generally it requires a somewhat higher temperature than silver steel. It should also be quenched in clean oil, not water or brine, taking due precautions against the ignition of the hot oil.

G-clamp

A simple clamp shaped as its names suggests operated by a single screwed pad in opposition to an anvil. Crude g-clamps are rarely satisfactory in engineering applications as they are liable to twist and loosen if heated or subject to vibration.

Gear

A toothed wheel designed for the transfer of power and motion by acting on other gears. A cogwheel is a gear whose teeth (cogs) are individually fitted.

Gear blank

A disk of metal prepared for the production of a gear. If the number of teeth of the gear is n, the diameter of the blank should be (n + 2)/DP or (n + 2) x module.

Gear cutter

A single or multi-point form cutter shaped to form the tooth spaces of a gear. In theory a differently shaped cutter is required to cut a gear wheel of any particular number of teeth, but the complex shape of gear cutters means they are expensive and/or involved to make. Fortunately, it is possible to compromise and still produce well-meshing gears, and gear cutters are made to cover ranges of numbers of teeth.

Gearbox

A mechanism containing a number of gears arranged to provide either a fixed or a range of ratios between the speed of its input and output shafts, with or without a change in the direction of rotation.

Gel battery

A type of sealed lead acid battery (SLA) that can be used in any orientation.

General arrangement

An engineering drawing that aims to give an accurate overall impression of an object or design, in particular by showing the relationships between the different parts and often helping illustrate the operation of the device.

Generation

The direct creation of a geometric shape from basic principles, rather than from a series of actions. Parts produce by generation are generally more accurate than those produced by copying as it is a single-step process.

German silver

Nickel silver.

Gib-strip

An adjustable, accurately formed metal strip arranged to take up the slack between the sliding surfaces of a machine tool. Most gib-strips are adjusted by a number of screws along their length, others are tapered and are adjusted by drawing them into the gap. Although good design tries to minimise the loads on gib-strips, their correct adjustment has a major impact on the satisfactory action of most machine tools.

Gilding

Any of many techniques for applying a very thin layer of gold to an object.

Gilding metal

A brass that is 95% copper and 5% zinc that has great ductility when annealed and is therefore much used for spinning.

Gland

A device for providing a seal around a reciprocating shaft, such as a piston or valve rod. Historically glands were usually stuffed with some form of flexible packing such as graphited yarn, or depended on

complex and carefully made metal seals. In recent years the use of o-rings or PTFE seals have become more popular, though tehse can demand a better surface finish than yarn packing.

Glass

1. A hard, amorphous, normally transparent, material made by the fusing of silicon dioxide, often with the addition of other minerals to give various different colours and properties.
2. A general term for any hard, amorphous mineral such as obsidian.

Glass fibre

Long thin filaments of glass with a variety of applications. Woven into a fabric or made into a random chopped mat it may be used to make glass reinforced plastic. Such fibres may also be gathered to form brushes suitable for light abrasive cleaning. Thicker filaments, with suitable support and protection, serve as optical fibres.

Glass Reinforced Plastic (GRP)

A composite material that consists of glass fibres (either woven sheets or random chopped fibres) embedded in a plastic resin matrix (usually a two-part polyester, but sometimes epoxy or nylon). Typically, items are made in female mould that is first treated with a release agent. Initially a coloured gel-coat is applied, followed by one or more layers of glass fibre, into which resin is thoroughly worked. It may also be applied as a ‘patch’ to repair holes or to attach or fair in items onto a structure. GRP is a strong, light material that is resistant to the propagation of cracks and hence catastrophic failure resulting from localised damage. It is vulnerable to degradation by ultraviolet light (including sunlight) unless precautions are taken.

Globe valve

A valve with a round body, typically between two flanges.

Glow plug

A heater element used to facilitate ignition in certain types of internal combustion engine. On diesel engines it is often used as an aid to reliable starting. On smaller glow engines the plug has a platinum coated element which is heated for starting, but remains hot during running because of catalytic combustion. The usual glow plug thread

is 1/4” 32 tpi in various lengths, and the voltage is normally either 2V or 1.2V (for more modern plugs).

Glue chuck

A temporary arrangement whereby a difficult to grip workpiece is simply glued to a faceplate using turner’s cement. See also solder chuck.

Gnomon

The pointer of a sundial. There are two sources of error in the time indicated by an accurately positioned sundial. One is the inclination of the earth’s axis, and this can be eliminated by positioning the gnomon parallel to the earth’s axis. For example at 52° N, the gnomon should be angled at 90-52 = 38° from vertical, aligned north/south. The second error accrues from the elliptical shape of the earth’s orbit, and can be calculated by reference to the equation of time or the use of an analemmatic sundial.

Go/no-go

A type of gauge that indicates whether or not the size of the part tested lies between two limits.

Goggles

Eye protection, as essential accessory in any workshop.

Gold standard

At one time the value of the major currencies of the world was underwritten by each nation’s gold reserves, long abandoned but the expression is still used to denote the very best, or most reliable quality.

Gooseneck

A bent pipe, for example that connecting the handle and the burner of a blowtorch.

Governor

A rotating device that operates a valve or otherwise controls the operation of a machine in order to regulate its speed, often within very narrow limits.

Graduations

Markings to allow the accurate incremental setting of a device ore the reading off of dimensional measurements.

Grain size

The mean size of individual crystals in a metal.

Grain structure

The mechanical properties of metals depend on their microscopic structure. Typically a metal is comprised of crystal grains of one or more compositions. The relative hardness and arrangement of these grains confer the metal with properties such as toughness and ductility. Work hardening occurs as a direct result of changes in the grain structure, where the grains physically move into new arrangements and ‘lock together’.

Graph

A diagram that shows how changes in two physical quantities relate to each other, for example temperature against pressure in a sealed cylinder.

Graphite

A soft, slippery, grey form of carbon with a molecular structure of many parallel sheets of carbon atoms. These layers can move freely over each other, making graphite an effective dry lubricant.

Graphited yarn

A piece of string heavily impregnated with graphite powder, a surprisingly effective way of providing a pressure-tight seal on a reciprocating shaft.

Graver

A hand turning tool, in the form of a cutting blade held with a suitable handle. A graver should always be used with a good solid rest, positioned so that there is no possibility of the tool being pulled under the work.

Gravity

A force of nature between any two bodies in proportion to their mass and inversely proportional to the square of the distance between them (at least for our purposes).

Grease

An emulsion of oil and/or wax in water. Grease is often used as lubricant in areas which need long-term lubrication and the cooling effect of an oil bath is not needed, or where regular oiling is impractical or undesirable. Many greases have extra ingredients such as PTFE or molybdenum disulphide to improve their performance. Over time grease can degrade and become hard.

Grease gun

A lever operated syringe used to force grease into bearings.

Grease nipple

A fitting with a small central hole used in conjunction with a grease gun to inject grease into a bearing, often pushing used grease out of the way.

Great Western Railway

A railway company established to link London to Bristol, and

ultimately serving the whole of the south west and most of Wales. Its Swindon Works were once one of the largest and busiest engineering works in the world. Most of its original permanent way was engineered by Isombard K. Brunel to broad gauge, though it was later standardised. It survived the inter-war grouping of the many small railway companies, until the establishment of British Rail.

Greenly. Henry,

An early exponent of the design of small locomotives, including commercial designs for miniature railways up to 15” gauge.

Greensand

A mixture of damp sand and clay used for making moulds for metal casting. Named from the greensand of the Weald in Sussex (an area that was one of the centres of the pre-industrial revolution iron industry), a friable sandstone that weathers to produce such material.

Grey cast iron

A shock-resistant form of cast iron that is easily cast into intricate shapes. It machines well because the carbon it contains is in the form of inclusions of graphite, which acts to lubricate the cutting tool and the surrounding iron matrix is relatively low in carbon and well annealed. The free graphite can make machining cast iron a rather dirty task.

Grinding

A process of gradual metal removal that relies on the use of abrasive wheels. A typical workshop bench grinder is a rough and ready shaping and sharpening tool, whilst at the other extreme a surface grinder is able to work to an extremely high level of precision.

Grinding point

A shaped (not necessarily acutely pointed) grindstone mounted on a shank, usually used with some form of hand-held rotary tool

Grinding wheel

A rotating disk of abrasive material which is used to shape metal either roughly, or in advanced grinding machines, with great precision and accuracy. Various grades of wheel are available with basic wheels being for general purpose work such as sharpening HSS tools, while

‘green grit’ wheels can be used for grinding carbide tooling. All grinding wheels should be tested for cracks (they should ring clearly when tapped) before mounting and never be run faster than the safe speed marked on the wheel. The disintegration of a grinding wheel under power is potentially one of the most dangerous workshop accidents.

Grip-tru

A proprietary name for Pratt Burnerd’s micro-adjustable self centring lathe chucks.

Grit

A measure of the fineness of an abrasive. Despite the march of metric measurement, grit sizes are still quoted in particles per inch, so 50 grit is coarse and 1200 grit is extremely fine.

Grit blasting

A variation of sand blasting using grains of a hard material, usually carborundum.

Groove

A shallow slot.

Ground

Finished to size by a mounted abrasive wheel, often using a surface grinder.

Ground flat stock

Gauge plate.

Growth

A dimensional change in heat-treated or cast metal caused by changes in the grain structure during ageing. The atoms literally move into a new crystal arrangement that has a different spacing, ultimately causing a detectable change in the size of the specimen. This effect should be borne in mind if hardening objects that will be a close fit, such as pistons for small compression ignition engines. Such a part should be allowed to age, perhaps for many weeks, before finally lapping to size.

GRP

Glass Reinforced Plastic.

Grub screw

A small screw, threaded along its whole length and without a separate head.

Guard

An attachment whose function is to protect the user of a machine from contact with moving parts or from swarf or other debris thrown out by the machine. In industry the use of guards is strictly enforced, and many machines will not function unless key guards are in place. In the home workshop it is often tempting to operate machines without guards, especially as home users tend to change set ups more frequently. Guards around rotating grinding wheels are essential. When designing one's own workshop tools due attention should be given to including easily used and adjusted guards.

Gudgeon pin

A cross pin fitted to a piston to form the internal bearing surface for the little end of a connecting rod (in reciprocating engines without a separate piston rod). Gudgeon pins are typically a force fit in the piston and a running fit in the little end. For model engineering purposes they are often made of hardened and tempered silver steel, brought to a good polish. Sometimes it is advised to fit pads of a softer material at the ends of the gudgeon pin to prevent it scoring the cylinder, but this should not be required if the pin is a good solid fit.

Guide Bar

A device used to ensure that a piston rod stays in line with its cylinder. The device attaching the rod to the guide bar is known as a crosshead.

Guide ring

A piston ring at the bottom of a piston that has the role of preventing the piston twisting and jamming in the bore, rather than of maintaining compression.

Gullet

The space between the teeth of a saw or similar cutter. The size of the gullet is important, as it represents the space into which each chip of swarf has to fit. If the gullet is too small, due to over-sharpening or poor choice, a saw will not cut.

Gun drill

A precision drill, usually adapted to run coolant to the cutting edges, for drilling long, deep, accurate holes.

Gunmetal

A bronze that machines well, and is strong and resistant to corrosion. It is often used for boiler fittings and small castings.

GWR

Great Western Railway, or according to enthusiast's God's Wonderful Railway. Detractors might say Gauge Went Rong (*sic)*.

H

Hacksaw

A metal cutting saw comprising a handle with a long bow, used to hold a hacksaw blade under tension. Most hacksaws have a blade holding system that allows the blade to be turned in 90° increments to allow cutting near an edge.

Hacksaw blade

A metal-cutting saw blade designed to work under tension. Avoid cheap carbon-steel hacksaw blades, unless used with great care and plenty of cutting oil they overheat, lose their temper and blunt quickly. Better quality alloy steel blades can be obtained, but the best blades are bi-metal ones which have a flexible back (to resist breakage) and teeth on a welded on HSS strip. Normally the blade should be fitted so it cuts on the forward stroke. The commonest tooth pitch is 24 tpi or 1mm. Hacksaw blades are set alternately as is normal, but they often have an additional ‘waviness’ to the cutting edge. These combine to make the kerf rather more open than might be expected from the thickness of the blade, preventing clogging. Broken, but not blunt, hacksaw blades can find further life in a padsaw.

Haining. John,

designer of many agricultural subjects, not just traction engines but also portables and agricultural machinery. His Suffolk Dredging Tractor is an unconventional classic.

Half round file

A file with a cross-section convex on one side and flat on the other.

Half-centre

A centre, normally tailstock mounted, that is machined partially away on one side to allow access to machine the very end to very small diameters.

Half-nut

A nut, split in two so that it can be clamped and released from a thread. The most typical example is that used to engage and release

the leadscrew of a screw cutting lathe.

Hammer

A tool comprising a heavy head on a long shaft. As well as iron and steel hammers in many sizes, brass and soft-faced nylon, copper or lead hammers can be obtained for use on easily damaged surfaces.

Hand chaser

A form tool used to finish turned threads. In the past skilled operatives would produce threads from scratch solely with the use of a hand chaser.

Hand drill

A drilling tool usually with dual handles and an integral drill chuck used for making holes.

Hand reamer

A reamer with a tapered lead on its end, designed to be run into a hole by hand to finish it to size. Usually they have a square shank allowing a tap wrench of suitable size to be fitted to the reamer. In contrast machine reamers have no lead and cut on their ends. Despite dire warnings, many model engineers experience few problems using hand reamers under power in machine tools.

Hand scraping

The skill of finishing surfaces to a high degree of finish and precision by hand. The essential technique is to use gauge blue on a reference surface, which is rubbed against the item being worked on. The blue highlights any high spots, which are then carefully reduced with a scraper. The quality of scraping (and hence the degree of contact between surfaces) can be assessed by the number of ‘spots per square inch’, one hundred being a typical target for a surface plate. Before the advent of precision grinding hand scraping was a key element in the production of bearing surfaces and remains a hallmark of many of the highest quality machine tools. Because of the high cost of hand scraping compared to mechanical alternatives it is much less common. Even fairly rudimentary scraping can be effective in improving the contact between poorly machine surfaces, so it remains a useful skill to develop.

Hand tool

An unpowered tool.

Hand turning

Any form of turning where the tool (such as a graver or a hand chaser) is held and guided by hand, rather than being rigidly fixed to the machine. It is normal to use some form of rest to support the tool. Hand turning can, with care and practice, be an effective and straightforward way of producing compound curves or chamfering edges. The practice of using a hand held file for finish turning is controversial, many writers considering the practice unsafe. In any case the normal caution of always ensuring a file has a properly fitting handle is even more essential if the file is to be used on moving work.

Handed

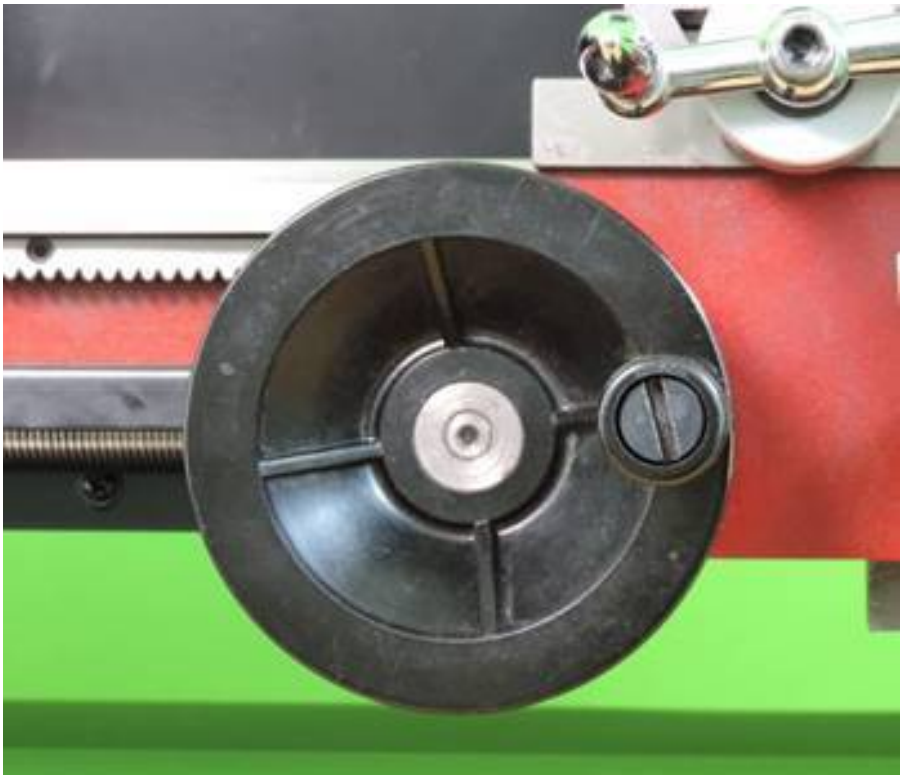
Of parts, being in two forms identical except that one is the mirror-image of the other like a pair of gloves.

Handwork

Any operation that is carried out with minimal mechanical constraint, such that the result depends to a large degree on the skill of the operator. Examples would be filing and scraping.

Handwheel

A rotary lever operated manually.



Hard soldering

The use of solders melting above about 400C; see silver soldering and brazing.

Hardening

The strengthening of metal by heat treatment or cold working. When carbon steel is heated above its critical point (typically 700-800°c) all the carbon in it goes into solid solution and forms austentite. As it is quenched more and more rapidly the layers of pearlite formed in the steel get ever finer. Eventually a point is reached, with a very fast quench, where angular crystals of martensite are formed. If quenching is too fast some austentite may remain; this will gradually convert into martensite by a process of ageing, possibly creating internal stresses and causing dimensional changes as the grain structure realigns itself. Martensite is extremely hard but brittle, and to be of practical use hardening must be followed by tempering. The hardening colours of steel can be used to judge its temperature sufficiently accurately for hardening.

Hardie

A hardened and shaped steel block used in conjunction with an anvil for shaping or cutting metal by forging.

Hardness

A measure of the resistance of a metal to penetration, and hence indicative of its resistance to wear, damage or deformation. Hardness may be measured by a number of tests such as the Vickers and Brinell hardness tests. It is also possible to judge hardness comparatively using a hardness gauge. Steels show a close relation between hardness and tensile strength, though this is not true of many other materials.

Hardness gauge

A circular disc with a series of pegs of known hardness arranged around its periphery. The pegs are used to scratch a sample, and its hardness is assessed as being between that of the hardest sample which cannot scratch it and the softest one which can. The hardness of the pegs is usually quoted in Brinell numbers.

Harrison. John,

a pioneer in the field of making accurate marine chronometers. Harrison built of a series of clocks, with many innovative features. He eventually made a timepiece sufficient accurate and robust enough to be used on board a ship for the determination of longitude by timing the change in the moment that the sun reached its zenith each day.

Hat

A useful head-borne method of carrying engineering materials. I. K. Brunel used his trademark stovepipe hat to store his working drawings (they once fell out when he bowed to Queen Victoria). Nikolai Tesla kept one of his small turbines in his bowler hat. Also useful for protection and keeping swarf out of your hair.

Head

The enlarged end of many fasteners that prevents them from passing completely through a hole.

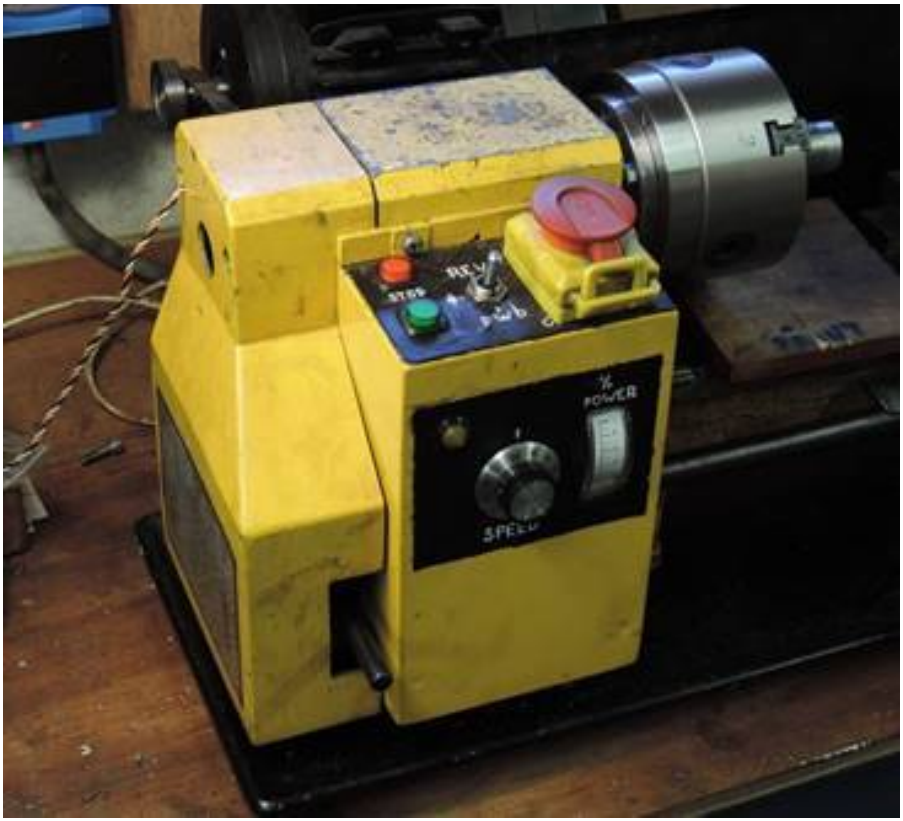
Headroom

The space between the workpiece and the tool. On lathes and mills with limited capacity careful thought about tool choice and workholding may be essential to achieve adequate headroom to work

accurately and safely.

Headstock

The part of a lathe which contains the rotating mandrel on which the work is normally mounted.



Hearth

A heatproofed work area used for high temperature processes such as forging and brazing.

Heat

The energy contained in a body by virtue of its temperature.

Heat engine

An engine that performs useful work by allowing heat energy to flow from a hot place to a cool one. The efficiency of a heat engine is ultimately limited by the temperature difference between its input and its exhaust. Examples range from steam engines to jet turbines.

Examples of non-heat engines would be electric motors, clockwork toys and weight-driven mechanisms.

Heat treatment

The alteration of the physical properties of a metal by the controlled application of heat. Heat treatment is used to harden, anneal, normalise or temper metals.

Heel

1. The end of the body of a file nearest the handle.
2. The back end of the cutting edge of a tool, for example the edge at the back of the conical end of a drill behind the cutting edge.

Height gauge

In its simplest form, a height gauge is an adjustable scriber mounted on a base. More complex devices resemble a vernier calliper up-ended on a base, and are used for making accurate vertical measurements. Both types are used for measuring and marking out on a surface plate or other suitable flat surface such as the bed of a lathe.

Helix angle

The angle that the spiral part of a worm gear or spring makes with the axis of the component.

Helping hands

A light-duty workholding device comprising a heavy base on which is mounted a crossbar bearing a pair of crocodile clips or other clamps. Often these devices also carry a glass or plastic magnifying lens. They are particularly useful for holding small objects for soldering, gluing or painting.

Hex

Hexagon; used as a prefix for stock, fasteners or other items with a six-sided cross-section.

Hexagon

A six sided shape. Regular hexagons are usually used for the heads of nuts and screws, rather than squares, in all but the oldest of machinery. Though a square provides a larger area to take the load, a

hexagon fixing's blunter corners are less liable to damage and allow it to be turned more easily in a confined space. Hexagon stock is available in both metric and imperial sizes and is convenient for the making of custom fixings.

Hexagon (hex) key

An L-shaped metal bar of hexagon cross section used as a tool to operate fasteners via suitable mating sockets. They are less likely to slip and can therefore transfer more torque than other types of drive. Hex keys may be obtained in many qualities, some are literally meant to be disposable after a few uses. It is well worth investing in both an imperial and a metric set of quality chrome vanadium Hex keys. Long series Hex keys can be very useful in awkward situations, but should be used with care as the length of standard Hex keys limits the torque they (and their mating fasteners) have to take. Ball ended hex keys can be used at a significant angle and are very useful for adjusting fasteners that are partially obscured. Also known as hex wrenches or allen keys. See also Torx key.

Hexagon head

A fixing such as a screw or bolt with a hexagonal head that allows it to be tightened with a spanner.

Hexagon socket

A six-sided cavity, usually in a fixing but sometimes in other parts, allowing the use of a matching hexagon key.

Hidden detail

Most engineering drawings will show some hidden detail by means of dashed lines. This usually makes it easier to understand how parts are shaped or fit together, but in some cases too much hidden detail can be shown making a drawing unnecessarily complex.

High carbon steel

Carbon steel with a greater carbon content that the carbon-iron eutectic.

High finish

A standard of machined finish where no visible machining marks can be detected on the work.

High pressure additive

An extra ingredient added to lubricants to improve their resistance to being squeezed out of narrow spaces under pressure. As well as being a useful property for oils lubricating heavily loaded bearings, this is a useful property in cutting oils.

High Speed Steel

See HSS

Hob

A rotary form tool, most typically one used to form gear teeth.

Hole

A cavity, which may be cast into a workpiece or produced by drilling, reaming, boring, milling or a combination of these and other techniques.

Home Shop Machinist

American term essentially synonymous with model engineer though perhaps with more focus on the processes of production than the product.

Hone

A tool used for honing, bearing one or more pieces of fine grinding stone. The shape will vary widely depending on the task the hone is intended to undertake.

Honing

A process for removing very small amounts of metal by gentle and controlled grinding. Used on a part machined nearly to size to produce a good finish and ensure high levels of accuracy, or to put a polish on a blade or cutter. Circular honing often uses rapidly moving pieces of grinding stone held on a support (hone). Honing should only be used to remove small quantities of material less than 0.001” (0.025mm). The sprung hones for ‘removing the glaze’ from automobile engine cylinders may be familiar, and in smaller sizes are excellent for finishing the cylinders of all types of engine. Honing typically leaves a smooth but minutely cross-hatched finish which tends to hold oil. See

also lapping.

Horizontal

Level, literally aligned with the horizon.

Horizontal engine

A steam engine in which the cylinder(s) lie horizontally to one side of the crankshaft.

Horizontal milling machine

A milling machine with a horizontal spindle. Typically more robust than a vertical mill of similar size but less versatile, few hobby workshops contain a horizontal mill.

Hornblock

The moving blocks that carry the axle bearings of a locomotive or railway wagon.

Horncheek

The bearing surfaces facing the horns in which hornblocks are fitted. The bar across the bottom of the horns is called a hornkeep.

Horsepower (hp)

The imperial unit of power. Once literally defined as the power a horse could sustain, lifting a 550-pound weight at one foot per second. 1 hp = 0.746 kilowatts. Note that indicated horse power, nominal horsepower may not always translate through to the actual amount of power available from an engine, or even reliable quantify the power of the engine at all. Brake horse power is, however, normally measured from the engine's output shaft.

Hot Air Engine

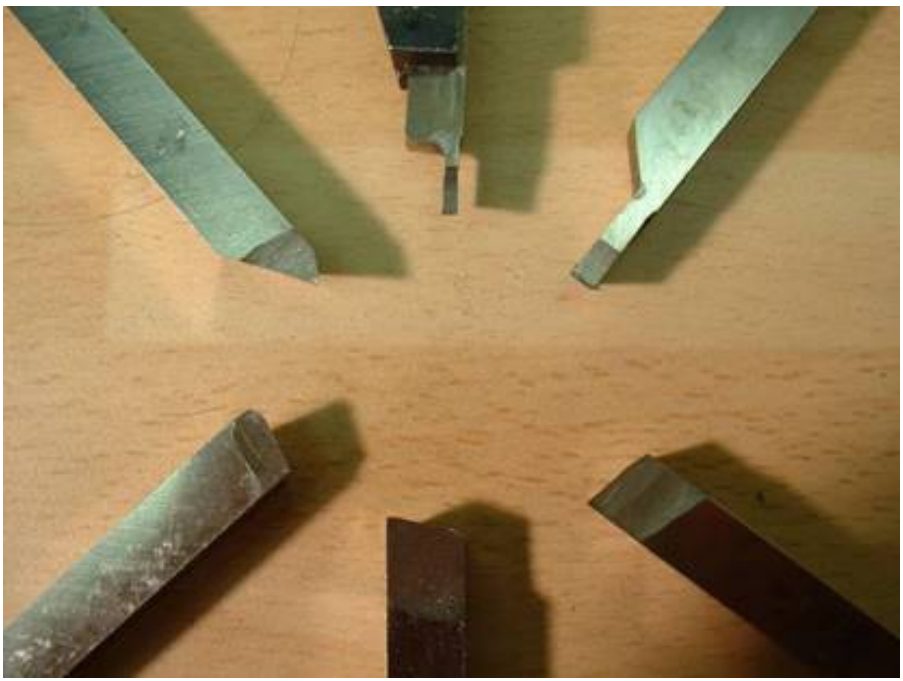
An external combustion engine in which air is the working fluid, including but not restricted to, Stirling engines.

Hot rolling

The forging of metal to shape by working it between rollers when red hot.

HSS

High speed steel, a wide range of alloy steels that show good resistance to wear and do not soften appreciably at even elevated working temperatures. It is now the commonest material for the manufacture of cutting tools, having displaced carbon steel in this role, although it tends to be softer, it tends to have longer working life. HSS can be readily ground so tools can be made from pre-hardened blanks. Annealed HSS can be worked by normal processes, but the resulting tools require hardening by rapid quenching in an air blast from white heat.



Hull

The main body of a waterborne vessel.

Humidity

The amount of water in the air expressed as a percentage of the maximum amount of water that could be held without condensation taking place at any given temperature.

Hunting tooth

An extra tooth added to one of a pair of gears to prevent ensure that

every tooth on each gear meshes with every tooth on the other. This has the effect of reducing wear and improving reliability, but naturally this can only be applied where the gear ratio is not critical, it would be disastrous if one of the camshaft gears of an engine had an extra tooth, for example.

Hydraulic

1. Of or relating to the behaviour of liquids.
2. Operated by liquid pressure.

Hydraulic lock

Because liquids are essentially incompressible, it is possible for some mechanisms (such as steam cylinders) to jam if they clog with water. The forces generated by such hydraulic lock can be severe enough to cause major damage.

Hydraulic test

A test for a boiler or other pressure vessel in which it is filled with water and raised to (typically) one and a half to twice its normal working pressure. Because water is virtually incompressible, even under great pressure the amount of energy stored in the vessel will be small, and the consequences of failure trivial compared with a failure when full of steam or compressed air, for example. For insurance puposes such tests should be carried out by a qualified boiler inspector.

Hydrochloric acid (HCl)

A strong inorganic acid. Its fumes are toxic and corrosive, but unlike sulphuric and nitric acid its spills do not self-concentrate.

Hydrogen embrittlement

A reduction in ductility of metals caused by the adsorption of hydrogen, for example during welding or electrolysis.

Hydrous

Containing water; used to describe crystals that contain water of crystallisation.

Hypereutectic steel

Carbon steels with more than 0.83% of carbon, they tend to be harder to machine in the unhardened state than lower carbon steels. See eutectic steel.

Hypotenuse

The longest side of a right-angled triangle, that opposite the right angle.

I

Idler

A gear in a compound train that lies between two other gears and does not affect the overall ratio of the train. Inserting an idler changes the sense of rotation of the following gear. As well as reversing rotation, an idler may be used simply to bridge a gap between two gears.

Ignition

The point at which combustion begins. For reliable ignition there are two requirements

The correct air/fuel mixture and a source of heat such as a spark, hot filament, rapid compression or a hot bulb.

IMLEC

International Model Locomotive Efficiency Competition. An annual competition originally devised by the late Martin Evans to encourage the development of both more efficient model locomotives and the driving skills of their operators.

Imperial

Used to distinguish the traditional British measurement systems for the various continental metric systems. Note that ‘imperial’ measures are still frequently used outside mainland Europe, including North America.

In situ

“in place”, used to describe situations where the tool is brought to the work.

Inch

The main imperial unit of length used in engineering. There are 12 inches in a foot. The inch may be subdivided in various ways, with fractions in a binary series (2, 4, 8, 16, 32, 64, 128) being the norm for work to be measured ‘by eye’. Tenths, twentieths, hundredths and, rarely, twelfths, may be used in this way. For precision work

thousandths of an inch ('thous') or micro-inches are used. Roughly the length of the end joint of a man's thumb, an inch was redefined as exactly 25.4 millimetres many years ago.

Independent chuck

A chuck with a number of jaws which move radially independently by means of individual screws. Even cheap chucks of this type may be used to centre work extremely accurately, with the assistance of a dti or dial gauge and a degree of patience. For this reason they were often preferred in the past when accurate 3-jaw chucks were beyond the reach of many. The four-jaw chuck is the most common design of independent lathe chuck, but designs with other numbers of jaws may be encountered.

Index plate

A circular plate with one or more concentric rings of holes, and used in conjunction with a dividing head or rotary table to provide accurate circular divisions.

Index ring

A circular graduated scale used to show the linear motion produced by the rotation of a handle. Usually index rings are lightly sprung to allow them to be moved to set a zero at any point.

Indexable insert

A mass-produced piece of carbide (or similar) with several cutting edges that can be fitted and replaced in a suitable holder. Such inserts can normally be rotated to bring fresh cutting edges into use, hence the term.

Indexable tool

A tool comprising a suitable holder and one or more indexable inserts. Such tools can take almost any form including end mills, lathe tools, form tools, parting tools and boring bars.

Indexer

A simple device for rotary division that has a limited number of discrete steps defined by a ring of holes or gear teeth into which a peg fits.

Indicated horse power

The power of a piston engine as ‘indicated’ by the measurement of the pressure within the cylinder throughout each stroke of the engine. Although this is a good measure of the work done in the cylinder, it may greatly over-estimate the available power as it does not allow for frictional and other losses (such as pumping coolant) elsewhere in the machine.

Indicator diagram

A diagram prepared by plotting piston displacement against cylinder pressure for a piston engine. The diagram should take the form of a closed loop whose area is proportional to the work done on each stroke.

Indicator gauge

A simple and robust alternative to a dial gauge that uses a lever principle to register small movements of a probe by larger movements of an indicator needle.

Induction furnace

A furnace that heats a metal charge by inducing powerful eddy currents in it, rather than by the conduction of heat from an conventional heater element.

Induction hardening

The hardening of parts of the surface of a steel or cast iron component by locally heating it by powerful induced electrical currents, followed by quenching.

Induction motor

An electrical motor with stationary windings around a central rotor. It has the advantage of not requiring slip rings of any kind. The speed of an induction motor depends on the number of poles and the frequency of the mains supply. On a 50 Hz supply a 4-pole motor runs at 1,500 rpm and a 2-pole motor runs at 3,000 rpm.

Infeed

The distance that a tool is advanced towards the workpiece in order to

put on a cut. Only equivalent to the depth of cut when the tool moves at right angles to the work.

Inherent accuracy

A property of some workshop techniques that automatically produce accurate results. Assuming well-adjusted bearings, a lathe will automatically turn a true circle, or bore a true hole in any object mounted on its boring table. Similarly, some techniques, such as the use of jigs, can produce accurate and repeatable work without the need for detailed measurement. Some practices simply remove or reduce sources of error, for example, mounting work directly on the table of a milling machine rather than in a vice.

Injector

A steam pump of high efficiency, with no moving parts, that uses steam from a boiler to inject feed water back into the boiler. The basic principle is that the stem is fed through a series of cones, the latent heat of the steam being converted into kinetic energy in a jet of feed water.

Inorganic acid

An acid that combines with metals to form an inorganic salt, such as sulphuric, nitric or hydrochloric acid. Inorganic acids are usually strong, even when dilute and must be treated with great care. In particular when diluting concentrated acid it is essential to add the acid to a greater volume of water. This is because if water is added to concentrated acid the heat given off may cause undiluted acid to be spat out.

Input shaft

The shaft of a gearbox or other mechanism which takes power from the crankshaft of an engine.

Inside admission

A steam engine where the steam enters the cylinders via the inside of the valve. Normally these are piston valve engines as slide valve engines rely on the steam pressure to hold the valve against the ports.

Inside calliper

A measuring device for use inside cavities or holes.

Inside frames

Frames that lie between the wheels of a locomotive, the more usual arrangement.

Inspector Meticulous

A mythical character obsessed with rivet counting and an advocate for accuracy above practicality in models. First identified by LBSC, who never entered any of his models in competition, claiming they would be derided as scale models and were meant to be engines capable of earning their keep.

Insulator

A substance that resists the flow of energy, as either electricity or heat.

Int 30

Most common ‘hobby’ size in the series of International Tapers, fitted to may industrial milling machines. A steep non-self holding taper relying on driving dogs. Also INT40 etc.

Interference fit

A class of fit where the sizes of two mating parts are such that they overlap i.e. The shaft is larger than its hole. Depending on the extent of the overlap and the nature of the materials this will result in a drive fit, force fit or a shrink fit.

Interference patterns

Patterns created when waves of similar wavelength impinge on each other, creating areas of constructive and destructive interference. With a light source the effect is to produce areas of light and dark, an effect much more pronounced when monochromatic (single colour) light is used. See optical flat.

Intermediate tap

See second tap.

Intermittent cut

When a workpiece has holes or gaps, or is irregular, any cut being

taken on it may vary in depth or the tool may even move completely away from the work at times. This is known as an intermittent cut and if the shock loads produced are severe it can be damaging to the machine, workpiece of the tool. Relatively brittle tungsten carbide tools are very vulnerable to breakage on intermittent cuts. If in doubt, slow the machine down and reduce the depth of cut.

Internal combustion engine

An engine in which the fuel is burnt within the engine, and the expansion of the combustion products directly acts (on a piston or turbine) to create movement. That is the burnt fuel/air mixture is itself the working fluid of the engine.

Internal taper

A hollow socket to give a precise fit with a matching external taper. See taper.

Internal thread

A thread around the inside of a hole, as in a nut.

International taper

A series of self releasing tapers used for holding tooling, particularly on industrial milling machines.

Inverse

Mathematically, the procedure of dividing 1 by a quantity e.g. The inverse of 2 is 1/2 or 0.5.

Inverted vertical steam engine

A steam engine in which the cylinder lies above the crankshaft; it differs from a table engine as the cylinder is supported by means other than a horizontal table.

Inverter

A electrical device that synthesises three-phase electricity from single-phase using digital techniques. More flexible than mechanical or passive converters inverters are becoming an increasingly popular method of speed control in amateur workshops. Used in variable frequency drives and often used as shorthand term for them.

Investment casting

A metal casting process involving the use of a ceramic shell formed around a pattern of wax or other material that is melted or burnt away before the metal is cast.

Involute curve

The path followed by a point on a string being unwound from a circle.

Involute gear

a gear with the shape of its teeth in the form of the initial section of an involute curve. They are prefered to cycloidal gears for most uses as they are less critical with respect to gear spacing and transmit

power smoothly in both directions. Unlike cycloidal gears, for a gear of any given size, pressure angle and number of teeth there is only one ideal tooth form.

Ion

An atom that has lost or gained one or more electrons and therefore bears an electrical charge.

Iron

A moderately hard, silver-grey metal that readily alloys with carbon. Virtually pure iron is known as wrought iron, is relatively corrosion resistant, ductile and is no longer a common engineering material. Cast iron contains high amounts of carbon, often as graphite. Steels contain controlled amounts of carbon and often other elements alloyed with iron, and come in many different types with hugely different properties.

Iron carbide (FeC3)

Cementite.

Iron filings

The very fine, dust like swarf produced when machining cast iron.

ISO

International Standards Organisation, used to prefix standards agreed by the organisation.

ISO Metric Threads

A number of series of threads to metric standards and available in a wide range of preferred sizes. The thread angle is 60° and the form has a sharp crest, so standard tool inserts can be used to cut the form and no special finishing is needed.

Isometric projection

A conventionalised way of drawing a three-dimensional view of an object without perspective. This can aid the engineer in visualising the shape and construction of an object, but as lines in each plane are drawn at different scales it is of limited use otherwise.

Isosceles triangle

A triangle with two of its sides of the same length.

Ivory

A hard, white substance obtained from the tusks of several animals, most notably elephants. Used for decorative handles, inlays and ornamental turning. It is no longer available due to the need to control the international ivory trade to control elephant poaching. Small amounts can be legally and ethically obtained from sources such as old piano keys and boot-sale cutlery, or bone can be used as a somewhat inferior alternative.

J

Jackshaft

An intermediate shaft bearing a crank used in the transfer of rotary motion. Contrast with a weighshaft that transfers linear motion.

Jacobs chuck

A maker's name that has become a generic term for three-jawed drill chucks. Unlike most economy chucks, most Jacob's branded chucks can be dismantled for servicing by pressing apart the body and subsequently reassembled.

Jacobs taper

A series of self-holding tapers used for drill chucks. In contrast to the usual arrangement of a socket in the mandrel of the machine, a male taper fits the socket of the chuck. There are many sizes with tapers ranging from less than 0.5" per foot up to nearly 1" per foot.

Jamb

1. Edge of a doorway.
2. Wedge in place; an archaic spelling of jam.

Jarno taper

A series of self-holding tapers running from 2 (the smallest) to 20. Unlike many series of tapers, the taper is constant at 0.600" per foot. The size is such that the diameter of the large end of taper n is n/8" and the small end is n/10" and the length of the taper is n/2". They may have a driving tang or be tapped for a drawbar.

Jaws

The clamping parts of a vice or chuck.

Jennies, jenny callipers

Odd-leg callipers.

Jig

A device that allows a machining operation to be performed with repeatable accuracy.

Jig borer

A very rigid and accurate drilling machine, resembling a vertical mill, with additional facilities to use slip gauges to allow extremely accurate location of the machine table for the purpose of setting out and drilling jigs and the like very precisely in two dimensions. The name relates to the making of holed plates to act as drilling jigs for production purposes. Rarely found in model engineer's workshops due to the cost compared to a vertical mill of similar capacity, the latter can often be made to serve the same purpose by careful positioning of the worktable. Many of the techniques of jig boring, such as toolmakers buttons can be used with other machines.

Jobbers drill

A general purpose twist drill suitable for general hole production in

metal.

Johansson gauges

Gauge blocks.

Joule

The SI unit of energy, one joule is the energy required to move a force of one newton, one metre.

Journal

A circular bearing surface.

Junior hacksaw

A small version of a hacksaw for cutting small metal objects and other materials.

Jury rig

A nautical term for emergency sails and rigging made in the event that the normal rigging is severely damaged or lost overboard. Used to describe any temporary solution to keep something running, such as string to replace a broken throttle linkage. Care should always be taken when setting up a jury rig, as even if it is safe to do so it may cause wear or damage to other parts.

K

Kerf

The slit made by a saw. Usually rather wider than the blade width, due to the set on the saw teeth, aside from special saws made with no set (such as some razor saws and most slitting saws).

Kevlar

A synthetic fibre of great strength.

Key

1. A metal bar inserted between a shaft and the boss of a wheel or other part to prevent rotation and sometimes used to ensure precise angular alignment.
2. A device for operating a chuck, usually in the form of a T-handle with either a square on the end or a bevel gear.

Keyless chuck

A design of drill chuck that can be tightened and released without the use of a separate key. At one extreme these can be rather cheap, inaccurate and with limited holding power, more expensive ones can grip much better and be of high precision (say 0.001” (0.02mm) TIR).

Keyway

A slot in a shaft or a hole for the insertion of a key to stop two parts rotating relative to each other.

Kg

Kilogram

Killed spirits

A flux for soft soldering that is made by dissolving chips of zinc in hydrochloric acid until it ceases to evolve hydrogen (stops fizzing). Essentially it is a slightly acid solution of zinc chloride. It should not be used for electrical work and must be cleaned completely away as it is highly corrosive.

Kilo

A metric prefix meaning one thousand, also used as shorthand for a kilogram.

Kilogram

A metric measure of mass, being one thousand grams, approximately two and a quarter pounds.

Kilowatt

One thousand watts.

Kinetic energy

Mechanical energy possessed by a system because of its movement, equal to the product of its mass and the square of its velocity ($e = mv2$).

Klingerite

A material for making steam gaskets.

Knee

The moving part that supports the table on larger milling machines of the Bridgeport style.

Knife

A cutting tool with a long, thin blade, normally hand-held.

Knife file

A file with a long, thin triangular cross section.

Knife tool

A simple tool shape for general lathe use that is easily produced by grinding suitable relief on the three faces around the cutting point at the end of a square toolbit. Such a tool is normally set at an angle to ensure proper clearance of the cutting edges. Despite the name it bears little resemblance to a knife.

Knocking

A regular sound from an engine that indicates a mechanical or other defect such as a worn bearing or pre-ignition.

Knurling

A regular pattern for decoration or grip impressed on a round workpiece. Knurls can be straight or diamond shaped and of varying fineness. A knurl can also be used to increase the diameter of an undersized shaft that needs to fit securely in a hole, as the process of creating a knurl combines some cutting action with some deformation.

Knurling tool

A device, held in the toolpost (or sometimes the tailstock) of a lathe for the purpose of creating a knurl. Simple types rely on being pressed into the work, balanced scissor-type tools squeeze the workpiece and place less strain on lighter lathes.

Knurling wheel

The circular forming part of a knurling tool. For a diamond knurl two wheels with spiral patterns of opposite hand should be used, but only one wheel is needed to form a straight knurl.

Kw

Kilowatt

L

Labyrinth seals

Interleaved (but not touching) seals around a shaft to create a longer path for any escaping gas or fluid. Such seals are used in situations such as around the shaft of a turbine, where lack of friction is more important than a perfect seal.

Lagging

In full size live steam practice it is normal to lag boilers, steam pipes and cylinders to minimise heat loss. As well as obvious materials such as asbestos (historically) or fibreglass, such materials as cardboard and wood have been used to lag the boilers and cylinders of steam engines.

Lamination

1. One of a series of layers, often of different materials or with their grain in different directions, combined to make a larger object.
2. The process of making such an object from separate layers.

Lammas toolpost

A three-way variation of the four-way toolpost devised by David Lammas. It has the property of pointing unused tools in more benign directions (both away from the tailstock and the lathe operator) and therefore is more suitable to be used for more than one tool at a time.

Lancashire boiler

A horizontal boiler with a twin furnace tubes along its length.

Land

A raised strip along the cutting edge of the flute of a tool, such as a reamer or drill, with a relieved area behind. The land is normally at the full width of the tool, and serves to enhance its accuracy by guiding the body of the tool into a cut hole.

Lantern pinion

A (typically) small gear with teeth fashioned as a circle of parallel metal pins between two end plates and resembling a lantern. Such gears mesh well with suitably modified cycloidal gears. They are often used in clocks and other mechanisms that require free running gears.

Lantern toolpost

An American pattern toolpost with a single central clamp screw that hold the tool down onto a curved 'boat' allowing its angle to be easily adjusted. It is not the most rigid of toolholding devices, and setting of the correct tool height may compromise the correct tool angles.

Lap

A shaped tool, possibly of wood, leather or a soft metal, designed to be charged with a powdered abrasive or polish for the purpose of lapping.

Lapping

The finishing of a surface by abrasion using a soft metal carrier (lap) charged with abrasive particles. The abrasive embeds in the softer lap and removes minute amounts of material. It is normal for the lap to be made adjustable (in the form of a split ring or cylinder) to keep up its action as the surface being worked comes to size. Lapping removes only tiny amounts of material, and depending on the abrasive used, can be used to bring surfaces to a mirror finish. It is a suitable process for the final finishing of parts such as well fitting pistons.

Laquer

A thin transparent coating used to preserve a high polished finish on metal items.

Large clearance fit

A class of fit suitable for allowing a moving part to pass through a stationary one without depending on it for location, with a degree of allowance for misalignment. For a 1" (25mm) diameter shaft in a dead-size hole the shaft should be 0.008" (0.20mm) undersize. Informally termed a 'rattling fit'.

Laser

Light Amplified by Stimulated Emission of Radiation or a device for producing such light. Laser light is coherent and powerful, Once

decribed as a solution looking for a problem, lasers are now ubiquitous in modern life. Laser cutting is a useful technique for cutting parts from metal plate, albeit only on a commercial basis.

Laser cutting

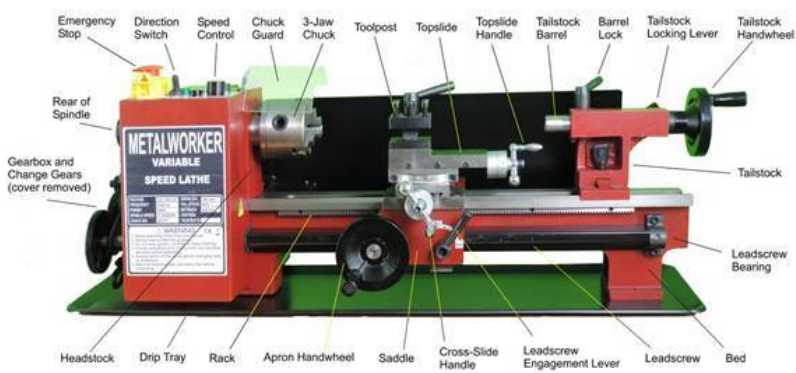
A technique for rapidly and accurately cutting metals using a high powered light beam surrounded by a gas jet. The gas used may be oxygen, which promotes burning and rapid cutting, or nitrogen which tends to improve surface finish. Marginally more accurate than water cutting, laser cutting can cause localised hardening along the edges of the cut.

Lateral strain

Strain in a body at right angles to an applied force.

Lathe

The main machine tool to be found in most workshops. A metalworking lathe typically comprises a headstock with a powered rotating mandrel on which work can be fixed and an opposed tailstock that can be used to provide further support for the work. Both are mounted on a rigid bed. A moveable carriage, on which is mounted a cross slide, and usually a further topslide, allows tools to be presented accurately to the work for the purpose of shaping it. Most model engineers' lathes can be described as 'back geared, screw cutting' (BGSC), meaning thy have the ability to run at low speeds and to move the cutter under automatic feed to create screw threads.



Lathe carrier

A lathe dog.

Lathe centre

Device fitting the taper in the head or tailstock of a lathe with a tapered point (usually at 60 degrees) which can be used to support a workpiece. Dead centres can be soft (for use in the headstock and rotating with the work. They can be trued up in place) or hard for use in the tailstock, in which case they should be well lubricated. Live centres contain robust bearings so they can rotate freely under load and they are used in the tailstock.

Lathe dog

A simple device fitted to work held between centres and engaging with a catchplate to allow it to be rotated in the lathe.

Lawrence. Lillian (Curly),

LBSC.

Laying out

The accurate marking up of workpieces in preparation for machining.

Layout blue

Marking blue.

Layshaft

A horizontal shaft used to transmit power or motion, a shaft in a gearbox other than the input shaft and output shaft. Historically large workshops would have overhead layshafts running the length of the building driven by a single powerful engine, and in turn driving many individual machine tools .

LBSC

The pen name of Lillian ‘Curly’ Lawrence, originally a fireman on the LBSCR the most prolific designer of small locomotives and the original populariser of coal-fired small locomotives capable of hauling the driver and passengers. Renowned for the accessibility of his constructional series, his ‘words and music’.

LBSC Memorial Bowl Competition

An annual competition for model locomotives to the designs of LBSC, in his honour and memory. The engines are judged both on their appearance and on their ease of handling by the judges, rather than being driven by their owners.

LBSCR

London Brighton and Sussex Coast Railway. One of the many pre-grouping railway companies.

Lead (lĕd)

A heavy, grey metal with a low melting point and high density. The heaviest of the commonly encountered metals. Lead and its compounds are poisonous. When added to metals in small quantities it can improve its machineability.

Lead (lēd)

Taper on a tool or component to ease its entry into a hole.

Lead acid battery

Electrical batteries made using lead plates and sulphuric acid. The voltage of each cell is nominally about 2 volts, and they are usually grouped in sixes to give a nominal voltage of 12 volts, though nearer 13.6V when charged.

Leader line

A line linking a note or a dimension to an object in a drawing. Arrows should be used where the line finishes at an edge and dot leaders should be used to link into the body of an object.

Leadscrew

An extended screw thread used for accurately positioning and driving the parts of a machine tool, for example when screwcutting on a lathe.

Leaf spring

A spring formed from one or more strips that operates by resisting sideways forces. Leaf springs are often used in the suspension of vehicles, but simple leaf springs can be found in all sorts of mechanisms.

Leather

A strong, flexible sheet material made by the process of tanning animal skins. In the days before synthetic materials leather was an important engineering material for uses such as bellows, power transmission belts and seals on pistons etc.

LED

Light Emitting Diode, a semiconductor based light source. Now higher power LED lights are readily available they are a useful source of intense light without great heat.

Left hand thread

A thread of the opposite hand to normal, such that it needs to be turned anti-clockwise to tighten it.

Lend-lease

A WWII arrangement that allowed Great Britain to obtain military equipment and machinery from the USA. Lend lease items ranged from warships to machine tools, many of the latter found their way into model engineer's workshops following the conflict and can still be obtained on the second hand market.

Lens

1. A transparent disk, used to modify the path taken by a light beam. The term is often applied to plain disks of glass or similar that have the purpose of protecting a bulb or reflector from dirt, damp or damage.
2. Any bi-convex object.

Letter drills

Along with number drills part of a continuous series of drills running from 80 (the smallest) to Z (the largest). Letter A is 0.234" and letter Z is 0.413". Up to letter K the gap between sizes is typically about 0.005", and from L onwards about 0.010", however, the spread of gaps is not regular and there are some large steps

That between N and O being the largest at 0.014". Metric approximations to letter drills are available, but it is more usual for metricists to use drills stepped by regular 0.1mm steps.

Letter punch

A metal punch with the raise shape of a letter on the end, usually obtained in full sets and used for the marking of metals. Even when used with great care the result is generally inferior to engraving.

Level

A device for measuring the horizontal truth of parts, machine or structures. Engineers' levels will typically read to very high levels of precision, say 1 part in 10,000 or about 20 seconds of arc.

Lever

A simple machine that produces a balanced couple around a pivot (fulcrum) to magnify force or movement. As well as reducing the force required, levers can also increase the sensitivity with which a force is

applied. The power of a lever is in proportion to its length, so it is often useful to limit the length of a lever to prevent overloading a delicate mechanism.

Lever clamp

A rapid action clamp that uses a cam and lever action.

Lever scroll chuck

A self-centring chuck whose jaws are moved by rotating an external ring aided, and tightened by the use of one or more levers inserted in holes in the ring.

Lignum vitae

A very hard, dense, dark wood that has excellent dimensional stability. It can be machined with sharp tools as if it were a soft metal. It can be used for the making of bearings or fixtures with the expectation of a long working life. One source of Lignum vitae is old bowling bowls, but with the advent of synthetic bowls this esoteric source is becoming even scarcer. It has a specific gravity of 1.3.

Limit gauge

A double gauge used for checking that a part's size lies within a tolerance range. The two test points will be marked go and no-go, and when only the 'go' points fit the part it is the correct size. Such gauges are useful whenever a series of parts must be made to be interchangeable.

Linear action

Describes something that operates along a line, in contrast to rotating.

Linking up

Adjusting the valve gear of a steam engine to make the cut off earlier to promote expansive working and increase efficiency.

L-ion

A rechargeable electrical cell chemistry with a particularly high power density and light weight, but requiring sophisticated chargers for safe use. It has a nominal voltage of about 3V per cell.

Lip clearance

The backing of the conical tip of a twist drill behind its cutting edges.

Li-poly

An advanced development of L-ion cells.

Liquid

A state of matter; a fluid, essentially incompressible but able to take any shape.

Liquidus

The temperature at which a warming solid mixture will become wholly liquid.

Litre

The metric measure of volume, one thousandth of a cubic metre and approximately one and three-quarter pints.

Little end (bearing)

The gudgeon pin or piston rod end of a connecting rod.

Live

In an electric supply the live conductors are those that carry a varying voltage, in contrast to the neutral conductor.

Live centre

A lathe centre fitted with a bearing so that it rotates with any work that it supports.

Live steam

1. Steam under pressure.
2. A generic term for all aspects of the model engineering hobby relating to steam-powered models.

LM14

An aluminium alloy of moderate strength and hardness often used for

casting, but also relatively easily machined. Also known as Y-alloy.

LMS

London, Midlands and Scottish Railway. One of the four large companies established as a result of the inter-war grouping of the many small railway companies.

LNER

London and North Eastern Railway. One of the four large companies established as a result of the inter-war grouping of the many small railway companies.

Loading gauge

On any rail line the outline within which all rolling stock must fit to ensure that it does not conflict with any lineside objects. For most elevated model railways designed to carry human drivers, the main concern is usually ensuring the track configuration and that of driving trucks do not conflict with each other.

Lobate

A polygon with convex sides whose width is constant (such as a 50p piece). A shaft or hole that is lobate may measure correctly but fail correctly with a matching part. The lobate condition can be hard to detect, but is proven when a part does not fit a ring or plug gauge of the same nominal size as its measured diameter.

Lock nut

A nut, usually of reduced thickness, that is tightened up against another nut or a part into which a screw is fitted, for the purpose of stopping it moving inadvertently.

Lock washer

A washer with castellations, tags or other features that enable it to prevent the rotation of a nut or screw tightened against it.

Locline

A proprietary system of interlocking tubular segments and nozzles used to make coolant delivery lines.

London and North Eastern Railway

The LNER was the post-grouping railway serving the eastern side of Great Britain.

London Midland and Scottish Railway

The LMS was one of the four post-grouping railway companies, operating chiefly through the north-west and north.

Long series

Many drills and milling cutters are available in long series forms. Their purpose is simple, working at the bottom of deep holes or next to tall shoulders. They are much more fragile than standard length cutters and must be treated with care. Do not expect long series end mills to cut along the whole length of their flutes!

Long series drill

A special twist drill for making deep holes, more flexible than jobbers drills or stub drills they are more likely to wander.

Longitudinal

Lengthways.

Longitudinal strain

The strain in a body along the direction in which a force is applied.

Loose pulley

See fast and loose pulleys.

Lost motion

The amount by which the input end of a mechanical system has to move before the output end moves; a measure of the amount of slack in the system. The term is more usually used in relation to linear systems such as levers and push rods. When referring to rotating systems such as gears and screws it is more normal to use the term backlash, though the overall principle is essentially the same.

Lost wax casting

A process for the production of complex and detailed castings using a disposable pattern made of wax. The wax pattern is assembled and finished to a high standard and then embedded in a mould material appropriate to the metal to be used. Once the mould has set, the wax pattern is melted out, the mould further heated to drive off any moisture, and the casting made.

Lubrication

The use of lubricants such as oils, greases and waxes to reduce friction. There is a bewildering range of lubricants available, although some types have fairly wide applications other are highly specialised. Most workshops will need some form of cutting lubricant and lubricants for the sliding and rotating parts of machine tools.

Lubricator

A device for supplying a measured amount of lubricant to a machine.

Lump hammer

A heavy hammer whose engineering application is (or ought to be) limited to the chipping of surfaces or the cutting of stubborn fixings with a cold chisel.

M

Machinability

It is possible to make relative assessments of how well different materials can be machined. For example, brass is generally more easily machined than mild steel, whilst carbon steel is tougher. Generally, metals with high machinability cut freely, produce short chips rather than long swarf, and easily take a good finish. Metals may have elements such as lead or sulphur added to make them more easily machined; such materials are described as free cutting. Some materials are known for their poor machinability, such as many bronzes that ten to ‘grab’ cutters or stainless steels that show rapid work hardening.

Machine

A mechanical device for doing useful work. This implies the use of energy to activate moving parts. A lever (with its fulcrum) is a machine at its simplest, but most machines comprise a co-ordinated collection of related mechanisms.

Machine crash

The unfortunate consequences of the moving and stationary parts of a machine tool coming together in an unplanned way, for example when a toolbit runs into a chuck.

Machine reamer

A reamer with end cutting teeth and no tapered lead-in, designed to be used under power, in contrast to a hand reamer.

Machine tool

A powered tool, noting that the source of power may still be the human hand, as in some shapers and drilling machines.

Machine vice

A low-slung vice designed to be fixed on the worktable of a machine. Such vices range from fairly crude drilling vices which can effectively hold work, but with limited accuracy, to highly accurate and powerful vices. Although a good machine vice can make workholding quick and

straightforward, there are many arguments in favour of the use of clamps instead, not the least increased headroom and the inherent accuracy of mounting work directly on the table of a machine.

Machineability

A property of a material that lends itself to working with cutting tools. For example, elements such as lead, sulphur and phosphorus may be added to metals to make them free-machining, reducing chip size and the cutting forces required and improving the surface finish without materially reducing the other desirable properties of the material. Stainless steels are notoriously hard to machine because of their rapid work-hardening, but free-machining alloys are available which have far better machineability.

Machining at one setting

Carrying out a full set of machining operations on a workpiece without changing the way it is held. This is frequent advice given when it is essential to achieve the maximum relative accuracy of machined surfaces. It will often be found that care is needed to ensure that this can actually be done; it will often require a fair degree of forethought in workholding. It should be obvious that if a workpiece is to be machined all over this cannot be done at one setting. Ideally machine non-critical surfaces first then reverse the work and align as well as possible and machine all the critical surfaces (such as the bore and rim of a flywheel). If this is impractical, alternatives include picking up the centre of the work using a dial gauge or mounting the work on an accurate mandrel.

Machining marks

Visible marks left on the surface of workpiece by the passage of the tool. Any machining marks noticeable on a prototype are likely to be invisible at model sizes, so it is normal to try to eliminate them from models, aside from semi-decorative finishes like scraping and draw-filing. On working machine tools, it is acceptable to leave appropriate surfaces with a neat as-machined finish, though some makers bring all surfaces to a high finish. For jigs and makeshift devices, the removal of machining marks that do not interfere with operation is pointless.

Machinists jack

A small device used as variable height packing or support when setting up for machining operations. The usual arrangement is a

compact body with a flat base and an internal thread, into which fits the raising screw, usually with a lock nut.

MacNaught compound engine

A compound beam engine with a high pressure cylinder adjacent to the flywheel and a low pressure cylinder on the other side of the pivot.

Magnetic base

A type of base used for holding various gauges and accessories, typically having a vertical 1/2" shaft on a heavy base containing a powerful magnet. Most such devices have a mechanical 'switch' to break the magnetic path allowing the base to be easily moved.

Magnetic chuck

A work holding device containing powerful magnets, normally used with a surface grinder. They have the advantage of allowing full access to the whole upper surface of even thin workpieces. In grinding the forces involved are relatively modest and act parallel to the chuck surface without tending to lift the work, but even so full safety precautions must be taken. Well suited to holding ferrous objects, they may be used for non-magnetic materials if they are restrained with magnetic clamping pieces. The upper surface of a magnetic chuck is usually of considerable thickness as it is normal to grind a thin skimming cut (perhaps 0.00025" / 0.005mm) off it before undertaking critical work. Magnetic chucks are generally unsuitable for milling work, due to the higher cutting forces and shock loads involved.

Magnetite

A naturally occurring mixture of ferrous and ferric oxide, a hard iron ore with magnetic properties.

Magneto

An electrical generator in which moving magnets move past one or more stationary coils. Because then avoid the need for brushes and slip rings magnetos are simple and were (and are) used as a source of low-tension electrical power for spark ignition systems. They do not produce high current and are not suitable for systems where more than the ignition must be powered. A magneto should be disconnected if a supplementary battery is used for starting, otherwise it may

become demagnetised.

Magneto bearings

Modest sized angular contact ball bearings that can be easily disassembled; named for what was a typical application for such bearings.

Mahogany

A relatively dense, dark timber derived from several rainforest trees. It lacks noticeable annual rings and is often used for decorative purposes, including lagging engine cylinders.

Malleability

The readiness of a material to be deformed. Malleable metals may be beaten or spun into shape without cracking. A malleable material may nonetheless work harden, and may need to be annealed a number of times as it is worked into shape. See ductility.

Malleable Cast Iron

An easily machined and relatively soft form of grey cast iron. Despite the name it cannot be wrought into different shapes when cold, but it is more resistant to fracture than common cast iron.

Malleableising

The process of converting hard white cast iron to grey cast iron by prolonged annealing causing carbon combined in cementite to concentrate as particles of free graphite.

Mandrel

The main rotating spindle of a machine tool of a machine tool such as a lathe.

A fixture for holding components by their central bore. On a lathe of unknown accuracy a mandrel can be turned in place to a push fit in the bore of a component, this may then be held perfectly concentrically. Expanding mandrels can be simply made by partially tapping the end (so a screw only enters with difficulty) and then splitting it, thus avoiding the need for a force fit. More elaborate expanding mandrels, comprising sleeves around a tapered core, can cope with a modest range of sizes.

Mandrel handle

Many lathe operations (such as screwcutting or tapping) are hazardous under power. An alternative to winching a chuck or drive belt around by hand is a handle that can be fitted into the bore at the rear of the mandrel. Many designs have been published and almost all use some form of expanding collet to grip the mandrel. Care should be taken to avoid any chance of operating the lathe under power with a mandrel handle fitted, because as well as being out of balance, the whirling handle is a hazard to fingers.

Mandrel nose

The end of a lathe spindle that is provided with a precision thread and register for fitting chucks. Such an arrangement has the disadvantage that chucks can come loose if the lathe is run in reverse or stopped suddenly.

Manganese

A metal used in the production of alloy steels. Manganese steel has increased strength and toughness.

Manganese bronze

Strictly a brass with a high zinc content together with small amounts of manganese and other metals. It is very strong and resistant to corrosion.

Manometer

A simple pressure gauge used for measuring relative pressure, comprising a u-shaped tube full of fluid. The pressure is calculated from by the difference in height of the fluid in each arm of the tube and its specific gravity. When the fluid is water, the pressure may be read directly in water gauge.

Marking blue

A rapid drying fluid applied by brush, rag or spray to facilitate marking out to guide machining operations. Traditionally a deep prussian blue, permanent felt tip markers are among alternatives that work equally well. On dark surfaces powdered chalk may be more useful

Marking out

The preparation of a workpiece for machining, normally by lightly scribing lines and centre-punching the location of holes.

Marshall, Percival

The original publisher of The Model Engineer and Amateur Electrician in 1898, and its editor for its first half-century. Widely viewed as the ‘father’ of the model engineering hobby in the UK.

Martensite

An extremely hard form of carbon steel, created by rapidly quenching it when in the austentitic state. The exact hardness depends on the amount of carbon in the steel, and varies from 460 to 710 Brinell. Martensite is extremely brittle and it must be tempered before use by re-heating it and allowing it to partially convert to softer, but tougher forms.

Mass

An intrinsic measure of the amount of matter in a body, that defines how it behaves in response to an external force. As all schoolboy physicists know, it is not to be confused with weight.

Master chuck

A special chuck that can be used to hold various smaller slave chucks with repeatable accuracy.

Mating parts

Two parts that interlock, normally classified by the self-explanatory terms male and female or plug and socket.

Matter

The material that fills space.

Maudsley. Henry,

A pioneering engineer most noted for his invention of the screw cutting lathe a device which paved the way for mass production and the industrial revolution.

ME Thread

Model Engineer Thread.

Mechanical energy

The energy an object possesses by virtue of its movement (kinetic energy) or its position or configuration (potential energy).

Mechanical movements

Various basic mechanisms that can be combined together to create more complex machines.

Mechanism

A device comprising various parts assembled together and operating by virtue of their controlled motion.

Meehanite

a form of cast iron with an easily machined fine texture obtained by prolonged heat treatment. It is available as lengths of continuously cast bar with a thin ‘skin’. In some cases, machining parts from solid meehanite is a viable alternative to using castings.

Megapascal (mpa)

A pressure of one million Pascals; 1 mpa = 1 N/sq. Mm = 10 bar = 14.5 psi, or slightly less than one atmosphere.

Metal

Elements characterised by relatively loosely bound outer electrons, which therefore tend to make them good conductors of electricity and heat, and liable to form positively charged ions in chemical reactions. Most metals are solids at room temperature, have fair to high strength and are easily alloyed with each other to obtain materials with different properties.

Metalworking

The art and craft of shaping metal. Although model engineers do not solely work in metal, it is probably their most typical activity.

Methylated spirits

Ethanol adulterated with methanol and (usually) died purple to discourage its consumption. It burns cleanly with a hot flame and as a result has long been used to heat small boilers. Its use for this purpose is now discouraged and solid fuel tablets are to be preferred when a boiler is to be used by children. “Meths” is also a useful workshop solvent, often effectively removing adhesive residues and the like that are not soluble in white spirit or turpentine.

Metre

The basic unit of length in most (but not all) metric measurement systems. The metre is too large for most engineering application so the millimetre (1/1000 of a metre) is used instead. The use of the centimetre (1/100 of a metre) is now deprecated although most metric rules are still marked in centimetres.

Metric

A shorthand term for any of the systems of measurement based around the metre, gram and second and/or their derived units. The hall mark of metric systems is that all units are used in multiples or subdivisions based on powers of ten, making decimal calculations simpler, but not lending itself to fractional or calculations.

Metric coarse

The standard series of metric threads encountered in everyday use.

Metric fine

A series of metric threads with finer pitches.

MGTBA

Model Gas Turbine Builders' Association.

Micro drill

A loose term for drills of less than about 1mm diameter, number 60 or about 1/16 of an inch. Extrapolating drilling speeds from larger drills to these small sizes can result in unrealistically high speeds that cause the drill to 'whirl' without cutting.

Micro-adjustable

Used of machines and tooling that have a facility for accurate adjustment beyond normal limits.

Micrometer

A screw-based measuring device that reads the distance between two opposed anvils. A traditional micrometer is read using a combination of a linear scale and a vernier scale on a rotating thimble. Digital micrometers read numbers directly with a mechanical or (now more commonly) an electronic readout.

Micrometer dials

Graduated dials attached to the adjusting screws of a machine tool to indicate the position and movement of the machine along the appropriate axis. Such screws may be metric or imperial and dials may be marked ambiguously (for example may are marked as 1 unit = 0.001”/0.025mm). While this may be a satisfactory approximation over small distances (the error is less than 2%, insignificant over say 10 or 20 divisions), it will be critical over larger amounts. On machines with electronic dials conversion between metric and imperial is usually completely accurate.

Micrometer paste

Gauge blue.

Micrometer stand

A heavy base designed to support a micrometer with its measuring gap facing upwards, so that I can be used hands-free.

Micron

A micrometre, one-thousandth of a millimetre or a millionth of a metre. Micrometre (um) is the correct term for technical usage but micron is more often encountered in engineering texts and avoids confusion with the measuring instrument of the same pronunciation.

Microscopic

Too small to be seen with the naked eye.

MIG (metal inert gas) welder

An arc welding device that automatically feeds filler metal wire, shielded by an inert gas, into the welding zone. Although the best results require considerable skill, MIG welding is the easiest welding technique to acquire.

Mild steel

A plain steel with less than .25% carbon. Mild steel is cheap and readily available in all sorts of shapes and sizes, the down side is that it does not have the tensile strength or hardness of other steels. It is therefore an excellent raw material for components that are not heavily stressed. Bright drawn mild steel is sized by drawing through a succession of dies. If it is machined asymmetrically it has a tendency to distort as due to internal stress, but this can be overcome by normalising prior to machining. Black mild steel is hot rolled to size and has a poor surface finish, but it has low internal stress. Precision ground mild steel is bright drawn mild steel that is ground to a very accurate diameter.

Mill

A popular term for a milling machine and also for end mills and other tooling used in such machines. (2) originally the action of powdering grain, hence watermills and windmills and by extension a historic term for other places of manufacture.

Millennicut file

A brand of file with very sharp, curved, high-quality milled teeth.

Millimetre

One thousandth of a metre, the usual unit used on metric drawings. Model engineers often work to a tolerance of about 0.02mm. There are 25.4 millimetres in an inch.

Milling

The process of shaping material using a milling machine.

Milling head

1. The part of a vertical milling machine that holds the spindle.
2. An accessory that can be fitted to some lathes to allow them to be used as a basic milling machine.

Milling machine

A machine tool in which the cutting tool is rotated and the work (usually mounted on an x-y table) is moved past the cutter. Originally conceived for the making of plane surfaces the use of form cutters, rotary tables and other accessories greatly increase their flexibility. A vertical mill lends itself to use for co-ordinate drilling and effectively substitutes for a jig borer. Milling machines have long usurped the shaper in the amateur workshop.

Milling vice

A heavy-duty machine vice designed to resist forces in all directions and to have maximum rigidity. It can be tempting to use a milling vice for nearly all milling tasks, but for critical work the extra rigidity given by clamping work directly to the machine table can make a big difference.

Milliput

A proprietary brand of epoxy putty.

Mini-lathe

A small 3 1/2” centre height lathe introduced in the 1990s with a modest price which has helped many new entrants to the hobby. Known in the USA as 7x12 and 7x14 lathes, from their capacity.

Minute

1. Sixty seconds of time.
2. In angular measure, one sixtieth of a degree of arc.

Mirror finish

A standard of surface finish such that a part is literally smooth and reflective like a mirror. Though over larger distances the surface may still be wavy (depending on the process used) the roughness will normally be very low (less than a wavelength of light) to achieve such a finish. Some metals (especially free-cutting alloys) readily machine to a mirror finish when worked with a sharp tool, others demand energetic polishing and may never be brought to a true mirror finish.

Misalignment

An error in the relative positions of two parts. Misalignment may be the result of the accumulation of small dimensional errors, or mistakes or limitations in the production process. Designs should be such as to allow for or compensate for such errors. They can also be reduced by working to a fixed datum to reduce cumulative errors.

ML7

A ground breaking small lathe produced by Myford from 1946, that set the general pattern for model engineering lathes for many years to follow. Despite being comparatively primitive compared to modern lathes, they remain popular with model engineers.

mm

Abbreviation for millimetre.

MMA (manual metal arc) welder

An arc welder using fluxed filler metal rods. Due to the simple equipment required and relatively low cost of the equipment, MMA welding is often the first choice of those who carry out relatively little welding work. It is significantly harder to get good results by MMA welding than MIG welding which requires more sophisticated equipment.

Mod

Module.

Model

1. A good example of something.
2. A representation of an object or concept. In hobby terms usually a reduced copy of a full-size object made to scale.

Model Engineer

One who follows the pursuit of model engineering.

Model Engineer (Magazine)

A magazine first published in January 1898 by Percival Marshall. Its audience was the increasing numbers of individuals seeking information in the areas of electricity and mechanics. The focus of the

magazine rapidly became on the engineering side (though up to the present day there is still some electrical content). The magazine itself became the mainstay of the emerging pursuit of model engineering.

Model Engineer (screw thread)

Two complementary series of constant pitch screw threads, one at 40tpi and one at 32tpi, in imperial sizes up to about 1/2" diameter. Being rather fine they are well suited to scale fittings and for cutting threads in relatively thin tubing.

Model Engineer and Amateur Electrician

Original title of Model Engineer (Magazine).

Model Engineering

The hobby or practice of making mechanical devices, generally involving the working of metal or other rigid materials. Historically the term included the making of working models of subjects such as steam powered engines and contrivances of all kinds, aircraft, ships and boats, automobiles and scale modelling of many other kinds (notably architectural models and display models of ships). Although not strictly modelling the production of instruments such as clocks and microscopes, as well as workshop tooling, are well established aspects of the hobby. During the latter part of the 20th Century with the burgeoning of a specialist press to support these activities (and the emergence of largely pre-fabricated models) the accepted scope of model engineering has contracted changed somewhat.

Model Engineers Workshop

A UK magazine, sister publication to Model Engineer (Magazine) focusing on tools and techniques rather than modelling. Established in 1990.

Model Gas Turbine Builders' Association

A club bringing together model engineers who have risen to the challenge of constructing compact and reliable high powered gas turbine engines. These engines are usually, but not always, deployed in model aircraft.

Model Power Boat Association

The UK umbrella body for builders and operators of model boats.

Model rocketry

A branch of aeromodelling, around the construction and flight of small, usually solid fuel powered, rockets. Though the hobby offers many model engineering challenges there appears to be little cross over, perhaps because except at the apex of the hobby it is dominated by prefabricated kits.

Module (mod)

A method of quoting the pitch of a gear wheel's teeth based on the diameter per tooth. Normally used for metric gears, so a 1 mod gear with 50 teeth will have a 50mm pitch circle, and a 0.5 mod a 25mm pitch circle. DP is the inverse of the diametrical pitch of a gear.

Modulus of Elasticity

The ratio of stress to strain in a material subject to compression or tension, within its proportional limit. Put simply it is a measure of how much a material distorts under a modest load, the greater the figure, the less elastic the material is. The figure gives no indication of how great a load a material can bear.

Mohs's hardness

A ten-point comparative scale based on a series of minerals of arbitary but increasing hardness. Talc is 1 and diamond is 10. Mohs's scale is only useful for minerals, not metals.

Molecular adhesion

The forces that hold molecules together are very strong, but operate only over very tiny distances. If two surfaces are very clean and flat it is possible for them to make sufficient contact that such forces can hold them together. Molecular adhesion is also the mechanism by which water or oil cling to a surface.

Molybdenum

A metal used in the production of alloy steels. Molybdenum steels are strong, but remain ductile and can be easily worked even when very

hard.

Monel Metal

A tough, bright, corrosion resistant alloy of two parts nickel to one of copper. It is smelted directly from a mixed ore naturally of these proportions.

Monochromatic light

Light that is all the same colour and hence the same wavelength, such as produced by a laser.

Monotube boiler

A boiler or steam generator comprising a wound metal tube, usually of stainless steel, capable of working at elevated temperatures and pressures. By virtue of containing a much smaller volume of water monotube boilers are considered to be safer than conventional boilers.

Morse drill

An old name for a twist drill bit, from the name of a US manufacturer.

Morse taper (MT)

A series of self-holding tapers running from 0 (the smallest) to (at least) 7. The taper is not constant but varies slightly around 0.625" per foot. They may have a driving tang or be tapped for a drawbar. There is also a stub series and half sizes may rarely be encountered. Morse tapers are used on the shanks of taper drills and also in the head and tailstocks of many lathes and mills.

Mould

A receptacle used to form molten metal into a useful shape, typically made of greensand. The mould is normally made by packing slightly damp moulding sand around a pattern. For some metals with lower melting points moulds of silicone or other metals (diecasting) may be used.

Mount. Anthony,

Designer and builder of stationery steam engines, noted for his choice of unconventional and challenging prototypes.

MPBA

Model Power Boat Association

MT

Morse Taper.

Muntz metal

A bright, hard brass of about 60% copper, 40% zinc originally developed as a replacement for copper for plating the hulls of wooden ships.

Muriatic acid

An old term for hydrochloric acid that may be encountered in old publications.

Music wire

The proper name for piano wire, stiff, hardened and tempered wire with considerable spring usually produced to standard wire gauge sizes.

Myford

Possibly the longest enduring of British hobby machine tool manufacturers, with along standing association with model engineering. Their products (particularly the ML7 later Super 7 lathes) have always been seen as being at the 'top-end' of model engineering equipment.

N

NAME

Northern Association of Model Engineers

Nanometre

One-millionth of a millimetre, a billionth of a metre.

Naphtha

An inflammable oil produced by distillation of coal, oil shale or petroleum.

Narrow gauge

Any railway of less than standard gauge, a bewildering array of sizes. Typically not used to describe model railways in the smaller gauges, although models of narrow gauge prototypes are referred to as such.

Neat cutting oil

A mixture of mineral oils (often with a high pressure additive) that can be used as a general purpose cutting lubricant. Many model engineers who do not wish to use a suds-based system, for reasons of mess, smell or the danger of corrosion with machines not in daily use. They often find that the careful application of neat cutting oil by brush or drip feed can bring significant improvements in surface finish and tool life. As well as facilitating turning and milling a little neat cutting oil can be a boon for drilling, reaming and tapping. It would not normally be used for machining brass or cast iron, though at times it can be useful on these metals.

Necking

An effect of a material being stressed beyond its yield point (if it has one) there is sudden increase in strain shown as elongation and thinning of the material (forming a narrow neck), often accompanied by a temporary reduction in stress. This can be clearly seen in an screw that has overstressed to the point of stretching, but without breaking. Because necking is accompanied by a decrease in cross section (and often by work hardening leading to brittleness) any affected parts should be discarded and the reasons for the overloading

of the component investigated.

Needle roller bearing

A bearing for taking radial loads that uses many small rollers. Roller bearings are normally supplied with just an outer race that should be a press fit in its housing to close it up to nominal size. The inner journal is normally the well-finished surface of the shaft, but suitable hardened inner sleeves can be obtained.

Negative rake

Describes tools in which the upper cutting surface is angled forward ahead of the cutting edge. Such tools are strong and suitable for use on very tough materials, but they generally demand greater rigidity and power than is available to most model engineers.

Neutral

In an electric supply the neutral conductor that carries a fixed voltage about which those carry a varying voltage (live conductors) alternate.

Newton

The SI unit of force. A force of one newton will cause a mass of one kilogram to accelerate at a rate of one metre per second per second. 1 N = 0.225 lbs. Force or 0.101 kg force.

Newton-metre

A unit of torque that is the effect of a force of one newton on a lever a metre long. It is roughly equivalent to a three-quarters of a foot pound.

Nhp

Nominal horsepower.

Nicad

An increasingly scarce rechargeable electric cell chemistry with a nominal voltage of 1.2 volts. Nicads are capable of delivering very high currents, but their cadmium content makes them difficult to dispose of safely and they are now difficult to source.

Nickel

A greyish metal with excellent corrosion resistance and high electrical conductivity. When nearly pure and in the annealed condition it is ductile and can be spun. When added as a component of nickel steels it increases their hardness and strength without reducing their ductility. It also allows hardening at lower temperatures, reducing problems of distortion.

Nickel silver

An alloy of about 55% copper with about 20% each of nickel and zinc. It solders well and is much used in the construction of small models from plate. It resists corrosion and resembles steel so can be used as an alternative to steel for making bright parts.

Nikolai Tesla

An outstanding engineer whose inventions included the Tesla turbine and the Tesla coil.

Nimh

A rechargeable electric cell chemistry with a nominal voltage of 1.2 volts that is replacing Nicad chemistry.

Nimonic

A tough, temperature resistant alloy typically used for the blades of gas turbines and other demanding applications.

Nitriding

A process of case hardening where nitrogen, not carbon, is introduced into the surface of the material. This involves the use of ammonia or other nitrogen rich material and is generally impractical in a home workshop.

Nitrogen

A colourless, inert gas comprising around 79% of the atmosphere.

Nominal horsepower (nhp)

A calculation of the power of a steam engine based solely on the dimensions of its cylinders, once made for tax purposes. As it ignores factors such as the steam pressure it generally gives a considerable underestimate of the power of the engine and it should only be used

as a relative guide to the powers of different engines of similar type.

Nominal size

The basic dimension of a part without taking account of any tolerance. For example, small diameter cast iron bar may be 1/16” (1.5mm) or more over nominal size, but precision ground silver steel will typically be well within 0.001” (0.025mm) of nominal size. Another example is metric screw fasteners, where the rounding of the thread profile means the top diameter is significantly less than the nominal size.

Non-rotative beam engine

A beam engine that produces only linear motion and does not have a flywheel to smooth its power transmission. Typically, such engines were used to drive pumps, where the lack of any rotational motion was no disadvantage.

Normal

At right angles.

Normal running fit

A class of fit for mating parts that must retain fair positional accuracy, whilst still being able to run freely whilst bearing a load, such as axles running in plain bearings. For a 1” (25mm) diameter shaft in a dead-size hole the shaft should be 0.0025” (0.06mm) undersize.

Normal working pressure

The usual pressure at which a boiler is designed to work. It is normally set using a safety valve which should be designed to prevent the pressure rising further, even when continually heated with no steam being drawn off.

Normalising

A way of relieving the tension steel by heating it to a red heat and allowing it to cool, distinct from annealing it does not necessarily affect the hardness of the material. It is always wise to normalise bright drawn mild steel if it is to be machined assymetrically, as it usually has high levels of internal stresses and can distort when machined. Black mild steel is sized when red hot and is less likely to distort.

Northern Association of Model Engineers

One of the two main groupings of model engineering societies in the UK.

Norton gearbox

A design of gearbox fitted to lathes by a number of 20th century manufacturers that allows screw cutting of a wide number of pitches without the use of change wheels.

Nose

The end of the mandrel or shaft (usually threaded externally) of a machine tool to which chucks, wheels or other accessories are fitted. Not generally used when the fitting is an internal or external taper or a flange.

Nozzle

The end fitting on the end of a tube designed to create a directed jet of fluid such as oil, steam, air or water.

Number drills

A series of drill sizes smaller than letter drills starting at No, 1 (0.2280”) down to No.90 (0.0059”). Typically available in sets of 1-60 and 60-80. Metric approximations to number drills are available, but it is more usual for metricists to use drills stepped by regular 0.1mm steps.

Number punch

Hardened steel punches with the raised shapes of numbers on their ends. Normally supplied in sets of nine punches (one punch serves for 6 and 9). The appearance of punched digits can be improved by using a guide to align the punches.

Nut

An internally screwed fixing that may be fitted to a matching bolt or screw. Nuts normally have six faces to allow them to be tightened up with a spanner or socket wrench. Historically many nuts were made with four faces, and such nuts may still be encountered from time to

time.

Nut runner

Another name for a box spanner.

Nyloc nut

A proprietary brand of self-locking nut.

Nylon

A versatile plastic available as rods that can be turned and used for engineering applications.

O

Oak

A dense, strong timber. Because oak contains high levels of tannins that can cause corrosion, it is rarely used in engineering although it finds uses in cabinet making and historically as an architectural material.

Oblate

Slightly flattened, for example the Earth has the shape of an oblate spheroid, slightly flattened at the poles.

Obtuse

Blunt; angled by more than a right angle (90°) the opposite of acute.

Odd-leg callipers

Callipers with one pointed leg and one with a blunt or notched leg, used for marking or measuring from an edge.

Odometer

An instrument for measuring distance travelled.

OHC

Over Head Camshaft.

Ohm (Ω)

The standard unit of electrical resistance.

OHV

Over Head Valve.

Oil

Long chain hydrocarbons liquid at normal temperatures. Oils of various types are used as lubricants, solvents and fuels.

Oil can

A can, often with a long spout for the precision application of lubricating oil.

Oil tempering

Tempering by heating in a temperature controlled oil bath.

Oiler

1. A device that stores oil and delivers it to a mechanism over time.
2. A fitting used to provide an entry point for lubricating oil.

Oil-hardening

A process for rapidly hardening suitable metals (typically some high-carbon steels) by quenching them from a high temperature in hot oil (with due safety precautions). Oil is a less drastic quench than water or brine and less likely to cause distortion.

Oilite bearing

A sintered bronze bush with the property of retaining oil in its porous structure.

Old money

Slang for imperial units of measurement, used by those who remember decimalisation.

Optical centre

A low-powered microscope arranged to have cross-hairs aligned with the axis of any machine tool to which it is fitted. This allows accurate location of the centre over a workpiece.

Optical fibres

Filaments of glass or plastic used for the efficient transmission of light using the principles of total internal reflection or refraction (in which latter case a fibre with a refractive index that changes across its cross-section is used).

Optical flat

A precision ground and polished piece of glass with faces that are parallel to an extreme degree. When placed on a nominally flat surface and illuminated, any divergence between the two will create a small gap that leads to the appearance of interference patterns as a series of light and dark fringes. In daylight each band will represent an increase in the gap of 0.00001” (250nm). Under monochromatic light from a sodium lamp or a laser, the bands will be more clearly defined and each will represent on-half of a wavelength of the light source.

O-ring

A sealing ring, typically of a temperature resistant silicone compound, but sometimes of rubber or other flexible materials. O-rings may be used (in pumps and steam engines for example) as piston rings, as seals around moving rods or as gaskets. In small sizes an o-ring that seals a moving component is fitted dead to nominal size of the stationary member and 1-2 thou (0.025-0.05mm) oversize to the moving member.

Ornamental Turning

A related hobby to model engineering, using complex lathes with many attachments to generate complex ornamental shapes.

Oroide

A non-technical term for a gold-coloured brass.

Orrery

A planetarium; a mechanical model of the Solar System which simulates the motions of the planets, and sometimes also their major moons.

Orthographic projection

A method of technical drawing whereby different views of an object are set out to scale and in defined relation to each other.

Oscillate

To vibrate or move to and fro, usually with simple harmonic motion.

Otto Cycle

The four-stroke cycle of many internal combustion engines poetically described as “suck, squeeze, bang, blow”.

Output shaft

The shaft from which power is taken from a gearbox.

Outside admission

A description of a steam engine whose valves are surrounded by high pressure steam which then exhausts though the middle of the valve

Typically slide valve engines.

Outside calliper

A calliper whose tips face inwards, allowing it to be used to measure the external dimensions of an object. There is a degree of skill in developing a technique to judge when the callipers are correctly set, they need to fit smoothly over the object being measured, without binding or being loose.

Outside cylinders

Cylinders that lie outside the frames of a locomotive.

Outside frames

Frames that lie outside the wheels of a locomotive.

Oval

Egg shaped, a less formal term than elliptical.

Overhaul

To examine closely and carry out preventative maintenance and any necessary repairs.

Overhead cam(shaft) (OHC)

An engine with the valve camshaft mounted in its cylinder head, acting either directly on the valves or through followers.

Overhead drive

In the days before electric motors became cheap and universally available, most workshops and factories would have a single power unit that would provide distributed power through line shafting. Typically, this would be in the form of an overhead drive with flat belts allowing individual machine tools to be activated or stopped by slipping the belts between fast and loose pulleys. Although the abundance of unguarded belts would now be regarded as a safety hazard, if used with care an overhead drive can still be an effective way of getting high power to small tools, such as a milling spindle fitted to a lathe.

Overhead valve (OHV)

A (normally internal combustion) engine configuration with valves at the top of the cylinders (in contrast to side valve). Overhead valve engines require more complex arrangements to operate the valves than side valve engines such as valve rockers or an overhead camshaft. The term is usually applied more narrowly to such engines that do not have an overhead camshaft.

Overheated

A metal is overheated if it is raised to a temperature where it develops a poor grain structure, but not actually burnt. It can be recovered by suitable heat treatment, such as normalising.

Over-scale

In scale models, proportionally larger than in the prototype. Although a few model engineers take incredible pains to make all parts to scale, in general many small load bearing or moving parts of a working model may be too fragile for reliability (especially when operated by full-size fingers). Such parts may therefore be made over-scale, but one should still aim for good proportions.

Overstress

The loading of a part beyond its safe working limit, such that it is in danger of failure due to deformation or fatigue.

Oxidation

1. A chemical reaction in which an atom gives up one or more

electrons.

2. A chemical reaction in which an element or substance combines with oxygen, as when a substance burns. Oxidation is the main process involved in metal corrosion. Most metals react readily with oxygen to form their oxide, with the rusting of iron and steel being the classic example. Metals that resist oxidation may simply be less reactive, such as copper which only forms its black oxide when heated strongly in air, or they may be very reactive but form a thin resistant layer of surface oxide, such as aluminium or chromium. Many other compounds are prone to oxidisation, such as plant based oils that degrade after long exposure to air.

Oxide

A compound of oxygen and at least one other element.

Oxygen (O2)

A colourless, odourless gas that comprises around 20% of normal air, and essential to support combustion.

Ozone (O3)

A form of oxygen with three atoms in each molecule, it is very reactive and rather poisonous. It may be produced from normal oxygen by electrical discharge, and gives the characteristic smell of sparking motors.

P

Packing

The use of material to fill in spaces to level, raise or otherwise secure and adjust the position of a workpiece or tool.

Packing block

1. A block of material used as a spacer when setting up a workpiece for machining.
2. Triangular blocks, produced in pairs, with one edge stepped so that they can provide packing of variable height.

Pad

1. A flat portion on a casting or fabrication to provide a fair seating for a fixing or another part.
2. An insert of relatively soft metal (often brass) used to prevent scratching or wear where otherwise hard parts would rub or knock together.

Padsaw

A simple handle suitable for holding short sections of hacksaw blade. Although the flexibility of the blade is a drawback, a padsaw handle can allow a cut to be made in confined places where a hacksaw cannot reach. It is easy to bodge a simple padsaw handle from a slotted piece of wood, clamped onto the blade.

Paint

A pigmented compound for colouring surfaces, applied by brush or spray. The quality of finish of the painted parts of a model is as important as any other element of the workmanship that goes into it.

Pannier tank

An arrangement of water tanks with one either side of the boiler of a locomotive.

Parallel

Of lines or surfaces, arranged so that if they are extended infinitely they will never meet. For engineering purposes ‘infinite’ is not a greatly useful concept, so actual parallelism is normally expressed in terms of the maximum deviation from true parallelism in micro-inches per foot or microns per metre, for example.

Parallels

Bars ground accurately for size and parallelism in matched pairs that can be used to support and align workpieces.

Parsons. Sir Charles,

The engineer who perfected the steam turbine and its application to both marine propulsion and the generation of electricity.

Parting off

The cutting off of parts in a lathe by plunging a cutting tool into the work. This machining operation is often treated with much trepidation by beginners and may experienced model engineers. Issues of importance when parting include ensuring rigidity of the lathe and tool, minimising overhang of the work, a sharp, well formed tool accurately on centre height, the correct cutting speed and a confident approach to feeding the tool into the work. Some writers advocate the use of a rear tool post.

Parting tool

A narrow tool that cuts on its end which is plunged into a workpiece when grooving or parting off material.

Pascal (P)

A pressure of one newton per square metre, a very small amount, and the megapascal and the bar are often more useful; 1 mpa = 1 N/sq. Mm = 10 bar = 14.5 psi, or slightly less than one atmosphere.

Pass

A single working movement of a tool across the work. ‘The shaft was reduced to size in three passes’.

Pattern

An object in the shape it is desired to make a casting, often made of wood, and used to make a mould. Patterns need to be made slightly oversize to allow for shrinkage of the metal casting, and to have a slight taper (draft) on their vertical walls to allow their easy extraction from the mould.

Pattern rule

A rule graduated oversize, so that a pattern constructed using it will automatically incorporate a shrinkage allowance.

Paxolin

A composite material made of laminated cloth embedded in heat-cured phenolic resin. Paxolin is remarkably strong, with a tensile strength approaching that of cast iron, but considerably greater flexibility. It can be machined and worked like metal, though tools must be sharp and care must be taken with holes as they tend to close up. It can be used for making leaf springs and gear wheels. It is also an excellent insulator and hence may also be used for mounting electrical components. It is available as rods, sheets and tubes, the lay of the fibres being different. Different grades of paxolin are named after various animals; whale and carp brands are often used by model engineers.

PCD

Pitch Circle Diameter.

Pearlite

The typical annealed form of carbon steel (Brinell hardness about 240), comprising hard crystals of cementite layered with rather more crystals of much softer ferrite. On heating above its decalescence point (700-800°c, depending on carbon content) pearlite changes into a solid solution of carbon in iron (austentite). Rapid cooling of austentite prevents these steels reverting to pearlite 'freezing' it in the form of very hard martensite (see hardening). Similarly hardened carbon steels can be annealed into the pearlite form by heating to above 800°c and allowing it to cool very slowly.

Peening

A process for surface hardening metals with repeated small blows, through a process of localised work-hardening. Traditionally a ball pien hammer is used, but other methods including shot-peening may be used.

Pendulum

A swinging weight suspended from a point. For modest degrees of displacement the period of a simple pendulum is proportional to the distance from its pivot to its centre of gravity, hence the use of a pendulum as the basic timekeeping device in many clocks.

Pentagon

A shape with five sides.

Percentage

A way of expressing fractions as parts per hundred.

Perforate

The act of making a hole. Having a hole or a series of holes.

Perimeter

The outer boundary of a shape. The sum of the lengths of all the sides of a shape.

Period

The duration of one repetition of a cycle.

Permanent deformation

A change in the size or shape of a component, the result of it being stressed beyond its yield point due to the application of external loads, that will not disappear when the load is removed.

Permanent way

The actual ballast, sleepers and rails that make up a railway line.

Petrol

Gasoline. A mixture of aromatic and short-chain hydrocarbons which form a volatile and relatively easily combusted fuel.

Pewter

A fairly soft, dark coloured alloy, historically of tin and lead but latterly replaced by lead free alloys with similar properties and colour.

PGMS

Precision Ground Mild Steel.

Phase

1. One of the different states of matter, solid, liquid, gas or plasma.
2. In a (molten or solid) mixture one of a series of states with different proportions and arrangements of the various constituents encountered over a range of temperatures between being fully solid and wholly molten.
3. The relative positions in their cycles of two periodic variations of the same frequency. For example three-phase mains has three lines that vary relative to neutral, each 120° out of phase with the other two; a two-cylinder double-acting non-compound steam engine normally has two cylinders 90° out of phase with each other.
4. Used as a name for the elements in such a relationship e.g. The phases of an electrical supply. Domestic single phase AC mains is derived by splitting a three-phase supply between different areas at the sub-station.

Phase converter

A device that allows three-phase electrical equipment to operate on a single phase supply. There are various ways of doing this, ranging from capacitor based solutions, through inverters to rotary

transformers.

Phenolic resin

An early type of thermosetting plastic, used in the making of Tufnol and similar reinforced materials.

Phosphor bronze

A copper alloy with high levels of phosphorus, characterised by high strength and wear resistance it is an excellent bearing material. It has a tendency to grab drills an reamers if care is not taken.

Phosphorus

A highly flammable element used in a many alloys, notably phosphor bronze.

Pi (π)

A constant relating the radius of a circle to its circumference (symbol π). Approximated by the fraction 22/7 or the decimal 3.142. There are 2 pi radians in a complete circle.

Piano wire

See music wire

Pickering governor

A type of centrifugal governor with three balls mounted around a central axis on leaf springs.

Picking up a centre

Aligning a workpiece by lining up the axis of a lathe or a mill with the axis of an already machined surface. It is difficult to do this consistently and accurately, and this is why it is always preferable to carry out critical by machining at one setting.

Pickle

An acid bath for cleaning metal

Pickling

The process of cleaning metal by immersing it in an acid bath, often to

clean of scale, spent flux and surface oxide after brazing or heat treatment. Many people use strong solutions of inorganic acids. A solution of citric acid (available in bulk from home brewer's suppliers) makes an excellent pickle and is far less risky to use. For small pieces of work household limescale removers also make an effective pickle. In the past the metal was often immersed as soon as its had faded from red hot to black, causing the acid to boil and spit, but aside from the hazards this approach can cause unnecessary strains on the work.

Pictorial representation

An illustrative drawing of an object, not aspiring to be an accurate engineering drawing, instead trying to convey an impression of the subject's general appearance.

Piercing saw

A small saw that holds a narrow blade in a bowed metal frame, essentially a small coping saw. Piercing saw blades can be obtained with very fine teeth (down to 70 tpi (about 0.4mm pitch) and, though fragile, are suitable for cutting out intricate shapes in sheet metal or small components. It is usual to use a notched wooden or metal plate as a support for the work when using a piercing saw.

Pillar drill

A one of the commonest machine tools and used for the making of holes with a rotating toolbit, comprising a workhead with a moving quill, on which a drill chuck may be mounted, above a work table. Larger pillar drills may have taper sockets in the quill, allowing chucks to be changed easily and for blacksmith's drills to be used.

Pilot

A cylindrical section on the front of a tool or other object that has the function of ensuring its correct alignment when inserted into a hole. A good example would be a counterbore.

Pilot gauge

A plug gauge for checking the diameter of a hole that has a small vee-groove made near to its end. This helps prevent the gauge jamming in the hole, and makes its use easier and more accurate.

Pilot hole

An undersized hole drilled to guide another drill or fixing. The exact size of pilot holes is rarely critical, unlike the size of holes for tapping. When drilling pilot holes for screws a hole the same diameter as, or slightly smaller than, the root of the threaded shank of the screw is appropriate.

Pin

1. A short, stiff wire with a head at one end and point at the other.
2. A metal peg used to retain a part in position.

Pin chuck

Pin vice.

Pin punch

A punch with a reduced end for tapping out small diameter pins etc.

Pin vice

A small collet chuck on the end of a short shaft. It may be used to hold small round objects while working on them, or to hold small drills allowing them to be used by hand for delicate work.

Pinion

The smaller gear of a pair. Also used as a general term for gears with relatively small numbers of teeth when undercutting may become an issue.

Pinking

A high-pitched tick-tick noise caused by the incorrect combustion of the charge of an internal combustion engine.

Pipe

A long tube used for transporting gas or liquid.

Pipe cutter

A device that has a hardened cutting wheel and opposed rollers, that is used to cut piping and tubing by rotating it around the pipe and gradually tightening it.

Pipe flange

A rim on the end of a pipe, generally with four (or a multiple of four) holes to allow it to be bolted to a second pipe or other fitting, such as a valve.

Pipe thread

Various series of threads designed for pipe fittings, most notable in that their names are the bore sizes of the pipes they fit (e.g. 1/4” BSP British Standard Pipe), and so the taps and dies are much larger than might be expected. Some pipe threads are unusual in being tapered.

Piston

A snug-fitting plug which reciprocates inside a cylinder. By coupling the piston to a crank this arrangement can be used to generate rotational motion from the expansion of a fluid in the cylinder or, in reverse, to pump a fluid. Pistons may be manufactured of many metals, depending on the type of engine. For steam engines cast iron and (in smaller sizes) gunmetal are often used. It is usual for the piston to be a different metal from the cylinder (unless piston rings are used). In high speed engines it is desirable to minimise the mass of reciprocating parts and the pistons are often made of light (but tough) alloys

Piston engine

Any form of engine that uses a reciprocating piston in a cylinder.

Piston ring

A sprung metal ring that is a close fit both in a ring groove around a piston and its bore, normally with the prime purpose of maintaining compression while minimising friction. Other purposes include guiding the base of the piston and scraping excessive oil from the bore. Several methods of making rings, usually from cast iron, have been documented. Critical factors are avoiding excessive spring force, achieving a good fit in the ring groove and keeping the ring end gap within reasonable limits.

Piston rod

A rod fixed rigidly to the piston of a (usually) double acting reciprocating engine which by virtue of a supporting gland or bearing.

Engines with piston rods typically have shorter pistons than those with connecting rods, because of the guiding action of the rod.

Piston toolpost

A type of quick change toolpost which uses cam operated ‘pistons’ to lock the toolholders in place.

Piston valve

A steam engine valve consisting of a bobbin that reciprocates within a sleeve alternately opening and closing various ports in the sleeve. Piston valves require greater accuracy in their making than slide valves, but in larger sizes they require significantly less force to operate, increasing efficiency.

Piston valve

Bobbin-shaped valve in a steam engine which moves back and forth in a cylinder uncovering ports cut into it. Typically piston valves waste less power in their operation than slide valves, but require more accurate machining and are less tolerant of wear.

Pitch circle

For the purpose of laying out gears, they can be treated as circular disks that roll together without slipping. This imaginary circle is the pitch circle of the gear and runs though the face of each gear tooth.

Pitch Circle Diameter

The diameter of a circle on which a number of elements are arranged, such as bolt holes on a cylinder cover or the teeth on a gear (see pitch circle).

Pivot

A point in a mechanism where two parts are joined so as to allow angular movement between them.

Plain steel

A steel which is comprised solely of iron and carbon, with any other elements only being present as impurities. Plain steels contain only iron and carbon, typically from 0.1 (mild steel) to 2% (carbon steel). Contrast with alloy steels.

Plan

An engineering drawing of an object from above. A view from beneath is a reverse plan. Views from the front, back and sides of an object are elevations. Strictly speaking, a full set of drawings are just that, not a ‘set of plans’.

Plane

1. A perfectly flat surface in space; the three dimensional equivalent of a line in two dimensions.
2. Woodworking tool for the removal of material as thin slices or shavings.

Plane of movement

The flat surface across which something is constrained to move only in two dimensions (such as a lever around a pivot).

Plane surface

A plane surface is one that is flat to a high degree of accuracy.

Planer

A largely obsolete machine tool that operates by moving a workpiece back and forth under a stationary tool. Broadly equivalent to a shaper, but usually of greater bulk and with a shaper the tool moves across the work, rather than the work moving beneath the tool.

Planetarium

A mechanical model of the Solar System; a device simulating the motions of stars and the planets by projecting them on the inside of a sphere. Contrast with an orrery.

Planing machine

A planer.

Planishing

A technique for beating metal into shape while creating a decorative pattern of hammer marks. The metal is typically work hardened by the process.

Plasma

A state of matter; a gaseous state which is energetic it is comprised entirely of ionised particles.

Plasma cutting

A method for cuttingsheet metal with good accuracy, though not comparable to laser or water jet cutting or wire erosion.

Plastic

1. A material that is easily deformed.
2. A synthetic polymer.
3. The condition of becoming flexible and ductile, as with many metals when heated.

Plate

A flat thin sheet of metal. A thin coating of metal over an object.

Pliers

Gripping tools with paired jaws operated by squeezing paired handles.

Ploughing engine

A traction engine used for ploughing, usually by winching a balance plough back and forth across a field, either with the assistance of another engine or against a ground anchor.

Plug gauge

A single or double ended cylindrical test piece used to check the diameter of a hole.

Plug tap

A tap with minimal lead used to finish threading a hole.

Plumber's solder

An alloy of lead and tin with an extended melting range, over which it has a rather 'pasty' consistency. This allows it to be worked in different ways to elecrician's solders which have a sharp melting

point.

Pneumatic

1. Relating to the properties of air.
2. Operated by air or gas pressure.

Point

1. In geometry that which has a position but no size.
2. The sharp end of an object that tapers down to nothing.
3. The end of a file opposite the tang.

Point angle

The angle between the cutting edges of a twist drill, normally 118° for general purposes. Increasing the point angle can make drills for thin materials less likely to grab or produced lobed holes.

Poisson's ratio

The ratio of longitudinal strain to lateral strain when a body is subjected to stresses within its elastic limit. It is a measure of how much the thickness of an object changes when it is stretched or squashed the higher the figure the more it distorts. For metals it is typically about 0.3, but can be as low as 0.2 for cast iron and as high as 0.5 for 'squashy' materials such as rubber.

Polishing

The use of mild abrasives (often used with a flexible carrier) to bring a surface to a high finish, normally without a detectable change in overall dimensions.

Polygon

A many-side shape. A regular polygon has all sides and angle equal.

Polymer

A complex molecule made up of long chains of repeating units of indeterminate length, typical examples are plastics and some adhesives.

Poly-vee belt

A form of belt drive using a relatively flat belt with multiple narrow vees. Typically suitable for small or large pulleys, large pulley size ratios and high power transfer. Often an ideal solution for amateur use as the pulleys are easily machined.

Pop rivet

A hollow aluminium alloy rivet with a wide collar and formed around a head on the end of a steel pin. The pop rivet is pushed through a hole and the pin stretched with a special tool. The pin causes the rivet to expand and then the head snaps off, remaining in the body of the rivet and leaving the rivet in place.

Pop safety valve

A safety valve designed so that when it operates the cross section of the steam passage is largely independent of the rate of steam release, so that it opens and shuts rapidly with a positive action rather than a progressive action.

Poppet

An old term for the tailstock quill of a lathe.

Poppet valve

A valve consisting of a round head on a long stem (running in a valve guide) that is held on a matching valve seat by a spring, as in a typical four stroke engine.. The valve is opened by a tappet or follower pressing on the stem and lifting the valve from its seat.

Positive action

A mode for a valve or device that is assisted to go from on to off and vice versa, using a spring, for example.

Potential energy

Mechanical energy stored in a system without movement, such as in a suspended weight, a compressed spring or a bent beam.

Potts Spindle

A once popular device for milling in the lathe sold as complete tools

or sets of castings for home finishing. The advent of affordable bench mills has seen the decline of such attachments.

Power

The rate of doing work, a measure of the capacity of a machine to perform work.

Power feed

An arrangement on a machine tool to allow the automatic movement of the work or a toolbit.

Power traverse

See power feed.

Precision

The degree to which something is measured. Precision is not the same as accuracy; just because a method of measurement gives a result to (say) three decimal places it does not mean it is accurate to the same degree. High precision without absolute accuracy can be useful when making comparisons, such as when matching parts, for example. Although a combination of high accuracy and precision is the ‘gold

standard' of measurement, the goal of the model engineer needs to be appropriate precision and accuracy.

Precision grinding

Processes for the very accurate sizing of work within fine tolerances. Surface grinders are used to produce plane surfaces, whilst centreless grinders are used for cylindrical work.

Precision ground mild steel

Mild steel ground accurately to size. PGMS is cheaper and possibly superior to silver steel for purposes such as shafts and axles that are not to be hardened.

Precision running fit

A class of fit for mating parts that must retaining a high degree of positional accuracy and the minimum of free movement. This fit would only be used for slow moving mechanisms under a light load, such as a rotary table or a precision instrument. For a 1" (25mm) diameter shaft in a dead-size hole the shaft should be 0.001" (0.025mm) undersize.

Preferred values

One of the issues with a metric system is that it is impractical (and unnecessary) to provide tools and stock in all potential sizes, but it is necessary to have a way of deciding which sizes to supply. Various series with similar proportional steps between each size have been identified, and these are known as preferred sizes. For example, metric screws go up in the following steps: 1, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 8, 10. The same principle is applied to items such as metal stock and electrical component values, though the number of steps and their exact values may differ. An alternative approach is to use values that change by a fixed proportion (as with BA thread sizes) though this inevitably leads to unusual sizes.

Preheating

The practice of gently and evenly heating an object to an elevated temperature prior the application of more intense heat for hardening, brazing or some other process. The purpose may be to minimise distortion or internal stress or simply to make a procedure easier or more efficient.

Pre-ignition

The ignition of the cylinder charge of an internal combustion engine too soon in the cycle. It has the effect of forcing the piston to compress the charge when it is trying to expand, causing overheating and possibly damaging or stopping the engine. Pre-ignition is often detectable by knocking or pinking.

Press

A hydraulic, geared or lever based device for applying pressure to objects placed within it to fold, cut or punch metal or make force fits. With a die fixed to the base and a matching punch, it can be used to cut shaped holes in sheet metal. A vice can fulfil some of the roles of a press.

Press fit

A class of fit where two mating parts are will resist turning forces, such as a bearing in its housing. Certain bearings whose outer race derive support from the housing need to have a press fit, and should not be held in looser housings with a retainer. Normally a press or other tool will be required to assemble the parts, and it should be possible to disassemble them without damage. For a 1” (25mm) diameter shaft in a dead-size hole the shaft should be 0.00075” (0.02mm) oversize.

Pressure

The force per unit area exerted on a surface.

Pressure angle

The angle between the line of action of two involute gears and a common tangent to the base circles of the two gears. In practice, this number indicates the relative proportions of the gear teeth. Most gears have a 20˚-degree pressure angle but 14.5˚ gears can be found. The smaller the pressure angle, the longer and thinner the gear teeth appear.

Pressure vessel

A chamber designed to hold water, steam, air or some other fluid under pressure. Care should be taken in the design and construction of pressure vessels as the potential energy stored in all but the smallest

can be considerable and the consequences of a failure can be disastrous.

Prick punch

A light centre punch suited for marking the location of holes but not creating a larger mark to guide a drill.

Primer

A paint used as an undercoat to prepare a surface for finishing coats. Primers are generally highly opaque and in neutral colours such as black, brown, white or grey.

Prism

A flat-sided solid with a constant cross section; glass block of such a shape used for separating light into its constituent components by refraction.

Prismatic

In the form of a prism.

Profile

The cross section of a piece of work, usually used to describe a shape to be produced using a form cutter, form tool or to be worked by hand tools such as a file or graver; the process of bringing the outline of an object to its desired shape. Profiling may often be carried out using form tools in a lathe, mill or shaping machine.

Progressive action

A mode whereby the action of a valve or other device varies non-linearly with movement, for example a steam regulator which initially opens slowly, then more rapidly.

Project

A series of co-ordinated tasks culminating in the achievement of an objective.

Projection

1. The representation of three-dimensional objects by means of

representing it as drawings from different directions. The commonest layout for working drawings is a three-view drawing with one view along each axis, normally arranged according to the conventions of first angle projection or third angle projection. Where it is necessary to provide a clear impression of the three-dimensional shape of an object drawings may be made in false perspective such as isometric or trimetric views. To avoid confusion all drawings should have information stating the projection used.

2. A protruding part on a larger shape.

Proportional limit

The point at which a material is stretched under load will cease to deform in proportion to the load. Technically it is the point where a graph of stress against strain deviates from a straight line. It is below, but often very close to, the elastic limit for a material. Some materials do not have a proportional limit.

Prototype

1. The full size inspiration for a model.
2. A trial version of a device constructed to prove the design and identify and rectify any shortcomings.

Protractor

A device for measuring or marking out angles. Protractors are available with moving pointers and vernier scales to allow greater precision.

Proud

Standing slightly above a surrounding surface.

PTFE

Polytetraflouroethylene, a flexible chemically inert plastic with remarkable low-friction properties. It remains flexible at low temperatures and is suitable for use up to a few hundred degrees, though at higher temperatures it degrades releasing toxic chemicals. It can be machined with sharp tools and is ideal for making seals and sliding parts. Some grades contain filler materials to improve its mechanical properties with minimal impact on its low friction.

Puddling

The process of making wrought iron by stirring the molten metal to allow oxygen in the air to burn off the carbon, purifying the metal.

Pulley

A wheel for carrying a drive belt, rope or chain. Pulleys for round belts are grooved or v-shaped to transmit power. For flat belts cylindrical pulleys are used, often crowned to keep the belt in alignment. Other types of pulley with teeth or single or multiple v-grooves work with appropriately shaped belts.

Pulley block

A device for holding one or more pulleys, usually fitted with hooks or eyes for the attachment of ropes or chains.

Pulse width modulation (PWM)

A form of electronic control that varies power by switching a full voltage supply on and off by different amounts. PWM is highly efficient as little energy is wasted in the controlling mechanism; for motor control it has the additional advantage of maintaining torque for smooth running at low powers.

Pump

A device for moving fluids.

Punch

A tool used for concentrating pressure, from hand held punches to those fitted to presses and used in conjunction with dies to press shapes from sheet metal. Ideally punches (and dies) should be hardened but mild steel punches will usually stand up to making short runs of components.

Push fit

A class of fit where the two mating parts are made very close to nominal size, so that a modest amount of force (finger pressure) is required to join them. It is used where parts will not normally rotate against each other, but can be readily disassembled without damage, such as locating pins to hold two parts in register. For a 1” (25mm)

diameter shaft in a dead-size hole the shaft should be 0.0005” (0.01mm) undersize.

Push rod

A rigid rod used to transmit force or movement in compression.

Pusher compound engine

A compound beam engine with a low-pressure cylinder on the opposite side of the pivot to the flywheel and a horizontal high-pressure cylinder directly driving the crankshaft.

PWM

Pulse Width Modulation.

Pyrometer

A high-temperature measurement device that works by comparing the colour of a heated filament with that of an object heated to red heat or above.

Pythagorus’ theorum

The square on the hypotenuse of a right angled triangle is equal to the sum of the squares on the other two sides.

Q

QCTP

A quick change toolpost.

Quadrilateral

A shape with four sides and four corners.

Quench

A liquid used for quenching. Typical quenches (in order of the rate of cooling) include water and brine (for silver steel); oil (for gauge plate); and air blast (for high speed steels).

Quenching

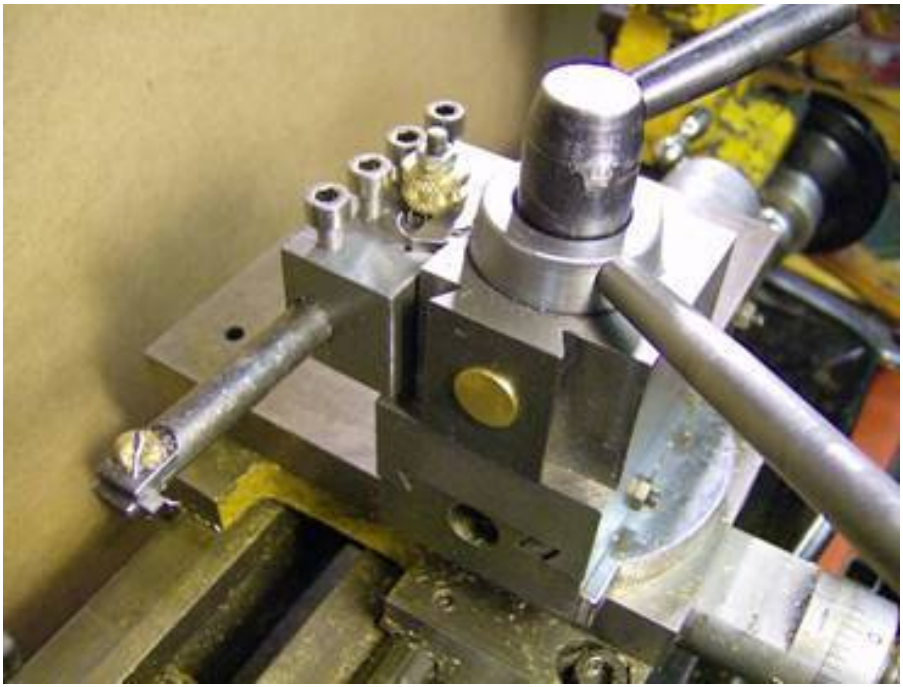
The process of rapidly cooling an object, usually with the objective of preserving some high-temperature structure (as in the hardening of carbon steels).

Quick blow fuse

A fuse designed to break rapidly in the event that its current rating is significantly exceeded.

Quick change toolpost

A device fitted to the cross-slide or top-slide of a lathe with interchangable toolholders using dovetails or some other arrangement to allow the rapid interchange of different tools. Usually, but not always designed so that tools are automatically returned to the same position and height.



Quill

The moveable spindle of a mill or drilling machine that moves within the head. For machines which have both a moveable head or table and a moveable quill, the latter is normally used to apply fine feed.

Quoin

Metal wedge inserted under the breech of a gun in order to raise it.

Quorn

A sophisticated tool and cutter grinder for the sharpening and manufacture of the most complex of tools, designed by Professor Dennis Chaddock. Although designed for mass production or home manufacture by Prof. Dennis Chaddock the Quorn is only available as unmachined castings, and its construction demands a good degree of care and skill.

R

R8 collet

A collet made to fit an R8 taper.

R8 Taper

A heavy-duty compound taper found on larger (and now some benchtop) milling machines.

Rabbet

Joint made by the fitting of a tongue in a groove, or such a groove itself.

Race

The grooved components of a ball bearing in which the balls run.

Rack

A series of gear teeth arranged in a straight line. Geometrically a rack is a section of the rim of a gear of infinite diameter. For the common involute tooth form, rack teeth are straight sided, the angle of the sides of the teeth being at the pressure angle of the gear to the perpendicular.

Radford. J. A.,

A model engineer renowned for designing a number of items of advanced workshop equipment.

Radial

Radiating from a central point, like the spokes of a wheel.

Radial drilling machine

A heavy-duty drilling machine with a head mounted on a rigid arm. The head can be moved along the arm and rotated around a pillar to allow holes to be drilled at various places on an object mounted on the machine table.

Radial engine

A piston engine with its cylinders arranged in a circle around the crankshaft. Unlike a rotary engine the cylinders of a radial engine do not rotate.

Radially

At right angles to the axis of a spindle like the spokes of a wheel.

Radian

A circular measure based on the circular constant π (pi). One radian is the included angle of an arc of a circle of length equal to the diameter of the circle. Therefore a full circle (360°) is π radians.

Radius

The distance from the centre of a circle to its edge.

Radius cutter

A form cutter with concave cutting edges designed to put a radius on corners.

Radius gauge

A set of templates for curves of various radii, generally in the form of a set of leaves each with a cut out and a rounded corner of the appropriate radius.

Rag

A piece of waste cloth. An essential adjunct to any workshop, oily rags are nonetheless prone to self-ignition and should be disposed of outside the workshop.

Rail

1. Horizontal bars on which rolling stock run. Rails for model railways are normally made of steel or aluminium, and may be had in various profiles appropriate to different scales.
2. Any horizontal bar for support or protection.

Railway

A permanent way with two parallel rails on which suitable rolling stock may run, and the associated infrastructure.

Railway gauge

The distance between the rails of a permanent way, the ruling dimension from which all other proportions of a railway follow. Common model gauges are 2 1/2”, 3 1/2”, 5” and 7 1/4”.

Rainhill Trials

An early competition for steam locomotives that marked the maturing of the new technology as a practical mode of transport.

Raising block

A plain or pierced metal block with top and bottom parallel, used to bring a workpiece or fixture to a more convenient height.

Raising block

A solid block with suitable mounting points used to lift a tool or workpiece above its normal level while maintaining the maximum amount of rigidity.

Rake

The angle that the upper surface of a cutting tool (i.e. the surface the cut chip moves across) makes with the work; it is given in degrees relative to a line at 90° (normal) to the surface of the work. The softer the material the more rake can be applied (making the edge sharper and increasing the wedge angle), but in harder materials the rake should be reduced to stop the tool being pulled into the work. Reduced rake also strengthens the tool. Brass has a particular tendency to ‘grab’ tools and the rake of tools for brass can be reduced to zero. In industry tools with negative rake may be encountered, but they demand greater rigidity and power than is available to most model engineers.

Rasp

A coarse file with many individual teeth, normally used for working wood and soft metals.

Rat tail file

A file with a circular cross-section, often of a fairly coarse kind.

Ratchet

A mechanism that allows a wheel to turn in one direction and not the other.

Ratio

The relative size of two quantities expressed as a pair of numbers.

Razor saw

Saws for delicate cutting work, typically with a thin, deep blade reinforced with a wider steel back and a relatively fine tooth pitch. Razor saws should be used with care, at a relaxed pace and using lubrication when cutting all but soft materials.

Reamer

A precision hole making tool capable of finishing a hole to an accurate diameter with a good surface finish. Reamers are not used for starting holes, only for the removal of relatively small amounts of material. Beware of using reamers to scrape off the ‘last few thous’ of a hole. For the best results and long life of the tool a reamer should be able to ‘bite’ the work and not be allowed to rub. Reamers should be run at 1/4 to 1/2 the speed of a drill of equivalent diameter, and should be well lubricated, even it this is just an application of neat cutting oil with a brush. A reamer should never be run backwards in a hole, as this will rapidly blunt it. Machine reamers are generally parallel along their length and cut on the end, while hand reamers normally have a tapered lead in along which the cutting takes place.

Rear tool post

A secondary lathe toolpost fitted to the back of the cross slide, often used to carry an inverted parting tool particularly on lathes where conventional parting off is found to be troublesome.

Rebate

A groove, notch or shoulder cut back into an object.

Recess

1. A depression or cavity in a solid body.
2. The action of making such a feature.

Reciprocating pump

A pump that relies on the action of a piston in a cylinder.

Reciprocation

A back and forth motion, as with a piston or valve in an engine.

Rectangle

A four sided shape with all its corners right angles.

Reduction

A chemical reaction in which an atom gains one or more electrons.

Refactory

The property of a substance to withstand the effects of heat.

Reference

An object used to test another object by comparison. For example, a 1” standard bar can be used as a reference to check the accuracy of callipers or a ,.

Reflection

The change in the path of a light ray when encountering a reflective surface such as a mirror or polished metal.

Reflexed

Bent backwards.

Refraction

The change in the path of a light ray when passing from one material to another with a different refractive index (such as air, water or glass).

Refractive index

A measure of the amount by which a ray of light passing from a vacuum into a transparent material is deflected.

Refractory

Heat resistant, as a firebrick. Refractory materials may or may not be good insulators.

Register

Complementary shapes on two parts designed to facilitate their fitting together in a repeatable alignment. To say two parts are in register implies they are correctly aligned.

Regular

Of a shape, with all its sides and angles the same size.

Regulator

A valve for controlling the flow of steam into a steam engine, and therefore the maximum power available. For greatest efficiency steam engines should be slowed by linking up the valve gear, rather than closing the regulator.

Rehardening

If carbon steel tools are overheated (by being forced to work too hard, or being ground too fiercely), they will loose their temper, become soft and blunt. Such tools can be rehardened, but first they must be annealed. There is a risk of burning out the surface carbon through the various cycles of reheating required. To avoid this wind a few turns of soft iron wire wound around tool and coat it with a paste of ground chalk.

Reinforced plastic

A composite material consisting of a plastic matrix reinforced with strong (but brittle) reinforcing fibres of materials such as glass fibre, carbon fibre or kevlar. The reinforcement gives strength, while the plastic gives flexibility and resistance to damage, resulting in extremely light, tough materials. The nature of the fibre reinforcement also resists the propagation of cracks, making these composites tolerant of localised damage.

Relative pressure

Pressure relative to a standard, typically the ambient or atmospheric pressure. For example, the difference in pressure between the inside and the outside of a boiler is what determines the stress upon the boiler shell, rather than the absolute pressure.

Relay

A solenoid operated switch.

Release

A mechanical control which allows some other mechanism to operate.

Relief

A reduction in the cross section of a tool or part to prevent interference, either by angling a surface or otherwise reducing it. (2) the angle that allows such relief.

Research

The process of systematically investigating a subject or problem.

Rest

A solid support for hand turning. A rest may be as simple as a steel bar held in the lathe toolpost, but more elegant and flexible solutions are height adjustable bars with various methods of attachment to the lathe bed or cross-slide.

Retainer

A relatively low-strength adhesive used to stop parts loosening or moving but still allowing later disassembly.

Retard

Delay the firing of a spark ignition engine by adjusting its timing nearer to top dead centre. This promotes smoother running at low speed and easier starting.

Retrograde motion

To move backwards; reverse.

Return spring

A spring arranged to cause a mechanism to revert to its original configuration when an activating force is removed.

Reuleaux diagram

A graphical way of calculating and depicting the timing of steam engine valves using circular diagrams.

Revolve

To turn around an axis.

Rheostat

A variable resistance used for controlling current and therefore the speed of a motor, brightness of a bulb etc. A rheostat is very inefficient compared with more advanced methods of control such as pulse width modulation.

Right-angled triangle

A triangle with one of its angles equal to 90°.

Right-hand thread

A screw thread of normal handedness, that is one tightened by rotation in a clockwise direction.

Rigidity

The resistance of a material to deformation under shear or torsional loads. Rigidity is one of the most desirable properties of any machine tool, as without a definite relation between tool and work neither accuracy nor precision is possible. Even if gross distortion is avoided, when using broad, overhung or heavily loaded tools a lack of rigidity may lead to chatter and poor surface finish. The easy way to provide rigidity in a design is to add mass, however, this need not be so and good design with reinforcing webs and a minimum of overhang and moving components can also facilitate rigidity. In practice, the set-up of a machine tool is critical to its rigidity, and well adjusted bearings and sliding surfaces are a pre-requisite for good results.

Ring gauge

A circular test piece used to check the diameter of a shaft.

Ring groove

An annular ring around a piston in which a piston ring is fitted. It is usual for the piston to be a good sliding fit in the ring (test by rolling the ring around the piston), but to have a limited amount of radial movement.

Rippa cutter

A heavy-duty end mill with chip breakers on its cutting edges. Typically capable of higher rates of metal removal than a standard

cutter.

Rivet

A simple, single-use, metal fastener in the form of a short cylinder with a formed head. It is used with a well-fitting hole and closed by deforming the small end to form a second head. Rivets may be made of iron, copper, steel, aluminium alloy or any ductile material. Small rivets are usually well annealed and closed cold, but larger steel rivets are closed when red-hot.

Rivet counter

Someone who pedantically checks the details of scale models, often used in lightly in reference to judges at model engineering competitions, but also less kindly in respect of those who would criticise any model that puts practicality before perfection.

Rivet punch

A hardened metal punch with a hemispherical or other shaped recess used to form the end of a rivet into a head.

Rivet set

A metal punch with a cylindrical hole in the end used to tap down the metal surrounding a rivet before it is closed.

Rivet snap

A rivet punch.

Rocket

An early steam locomotive that won the Rainhill Trials. It had several innovative features, including a multi-tube boiler, and set the basic pattern for all steam locomotives. It was much modified after its victory at the Rainhill Trials and is now at the Science Museum in Kensington.

Rockwell hardness test

To determine the Rockwell hardness of a metal sample a hard ball bearing or a diamond stylus is pressed into a sample under great pressure, sustained for several seconds. The size of the resulting depression is used to calculate the hardness of the sample.

Rockwell number

A number indicating the hardness of a material, the higher the number the harder the material, determined by a Rockwell hardness test. There are several Rockwell ranges, using different loads and penetrators, only numbers from the same scale are directly comparable unless a conversion table is used.

Rod

A part that is typically very long in proportion to its length, often used to transmit a reciprocating motion. Contrast with a shaft, which rotates rather than reciprocates.

Roll pin

A spring steel pin, c-shaped in cross section, that can be driven through a hole to secure two parts together. Such pins can be used to form a hinged joint, as is often used for car doors, but should not be expected to take a significant axial load or heavy duty.

Roller

A rotating wheel-like device often greater in width than diameter.

Roller bearing

A low-friction bearing using cylindrical or slightly barrel-shaped rollers between two cylindrical (for radial forces), coned (for axial and radial forces) or disc-shaped metal races (for axial forces only).

Root diameter

The diameter across the bottom of the tooth spaces of a gear. It is equal to the required blank diameter less twice the in-feed of the gear cutter.

Rope

A flexible cord comprising multiple strands twisted together.

Rotary engine

A radially arranged engine in which the cylinders themselves rotate.

Rotary phase converter

A device resembling an electric motor used to generate three-phase electricity from a single phase supply.

Rotary pump

A pump with a vaned rotor within a housing that operates like a

turbine in reverse.

Rotary table

A spinning work holding table, indexed with holes (often 12 or 60 to maximise the useful number of divisions) or graduated in degrees (with or without a vernier dial). It may be rotated directly or via reduction gearing. Distinguished from a dividing head which usually used some form of positive indexing in combination with reduction gearing to achieve a greater number of possible divisions with a high degree of accuracy and precision. It is possible to convert many rotary tables to dividing heads with the addition of suitable dividing plates, so the distinction is not always a clear one.

Rotary transformer

A special electric motor with extra windings that can be used to step up (or down) a DC supply. Now rarely used (small ones were once used to generate the high-tension (voltage) supply for battery powered vacuum-tube equipment. They may also be used to generate a full three-phase supply from a single-phase input.

Rotary valve

A valve that operates by rotating in its seat.

Rotating Centre

A centre for supporting work from the tailstock with accurate bearings allowing it to rotate with the work.

Rotation

A turning or spinning movement around an axis.

Rotative beam engine

A beam engine that incorporates a flywheel to smooth its power transmission and promote slow running.

Rotor

A rotating part.

Roughing

1. The rapid removal of material as the first stage of a machining operation, in preparation for finishing. Roughing tools tend to be strongly constructed to take heavy cuts while resisting wear.
2. The removal of material ‘by eye’ as a first stage in machining a part.

Round file

A file with a circular cross-section.

Rpm

Rotations per minute.

Rule

A linear measuring device in the form of a graduated bar. Rules may be flexible or rigid, and typically may be graduated in more than one system of measurement and degrees of resolution. Better quality rules may be marked with a standard temperature at which they are most accurate. ‘Ruler’ is not the correct term for engineering rules.

Rule stand

A simple device for holding a rule upright to aid with marking out. Rule stands can be as simple as a block with a basic clamp attached.

Ruling dimension

In a design that may be scaled, there is usually a key dimension (such as the centre height of a lathe or capacity of a vice) that sets the broad

parameters and proportions of all other parts.

Running down

Reducing the diameter of stock rapidly, often in a single pass.

Running fit

A class of fit used suitable for axles or pivots that must rotate freely. The degree of ease of fit can vary considerable depending on requirement. A precision running fit might be used for parts needing accuracy but with light duty (such as a rotary table) and would have no detectable ‘slop’. A free running fit would be used for parts that rotate continuously under load (such as locomotive axles) while being able to accept small changes in alignment caused by movement of the suspension. Between these extremes lie a close running fit and a normal running fit. Where both precision and free running are required (such as a lathe mandrel) then some form of special bearing would normally be used.

Rust

A bright orange hydrated ferric oxide of iron, commonly produced by its corrosion in damp conditions. The susceptibility of different irons and steels to rust varies considerably, with some types being effectively rust proof, some just developing a hard, resistant surface layer, and some rapidly losing their surface integrity. Rust has considerably greater volume than the original iron, and removal of even a thick coating of rust using agents such as weak acids can reveal surprisingly little surface damage. It is possible to convert rust into magnetitite or iron phosphate by electrolytic or chemical means and recover rusted items virtually to their original dimensions, although they will show dark staining.

S

Saddle

An alternative term for the carriage of a lathe.

Saddle tank

A water tank that wraps over the top of the boiler of a locomotive.

Safe edge

An edge of a file with no teeth on it, allowing working up to an internal corner without marking it. Before using such a file it should be carefully inspected, as there are often burrs that will spoil the safe edge, but these can be carefully ground off.

Safe working load (SWL)

A defined limit to ensure the safe use of a device, based on its design, duty and materials. It will incorporate a margin for error that will allow for variations in materials and he like, but safe working loads should not be exceeded.

Safety valve

A device fitted to a pressure vessel designed to vent if the internal pressure rises above a level with the safety margins. Safety valves fitted to steam boilers must be able to pass all the steam a boiler can generate.

Salt

1. Sodium chloride (NaCl), as in table salt.
2. More generally any chemical compound combining a metal ion and one or more simple or complex ions.

Sand

Fine grains of silica (silicon dioxide).

Sand blasting

A method of cleaning metals by spraying them with sand grains in a

high pressure air blast. Generally sand blasting is suitable for most hard metals, but care should be taken as fine detail or sharp corners can be eroded by the process.

Sand casting

A common method of casting metals by using a mould made by packing greensand around a pattern.

Saturated steam

Steam that consists of water vapour in equilibrium with liquid water; if it is cooled some of the water in it will condense, and if the water is heated more steam will boil out. At normal atmospheric pressure the temperature of saturated steam is 100°c, and increases with increasing temperature. Saturated steam is a vapour and does not follow the gas laws. In contrast dry steam is hotter for a given pressure and does behave as a gas.

Saturated

Steam or humid air when it is at the point that any reduction in temperature will result in the formation of liquid water.

Saucer wheel

A grinding wheel in the shape of a shallow saucer.

Savory. Thomas,

Inventor of a steam powered pump which allowed him to take out an all-encompassing patent for raising water by the ‘impellant power of steam’.

Saw

A cutting tool with a narrow, toothed blade.

Sawing

The process of cutting materials using a toothed blade. It is normal for hand saws to be used with the blade arranged to cut on the push stroke.

Scale

1. A series of graduation used to directly or indirectly read a measurement. A weighing machine.
2. The mathematical relation between the size of a model and its prototype, properly expressed as a ratio or fraction (e.g. 1/24 or 1:3). Sometimes expressions such as three-inch scale (meaning three inches to the foot or 1:4) may be encountered.
3. Surface oxides and other contamination on hot worked steel (black mild steel) or metal that has been heat-treated. It may be removed mechanically or through the use of a pickle.

Scale dividers

A pair of dividers in the form of two hinged legs, with hard points at each end and with a movable pivot near their centre. Such dividers can be used to directly scale up or down measurements in a ratio according to the position of the pivot.

Scale rule

A special rule marked in proportion to a given scale. For example a 1:12 scale rule might have graduations an inch apart, but marked as feet, and subdivided into twelve equal divisions marked as inches. This facilitates the production of parts or scale drawings from measurements of a full size subject.

Scales

A weighing balance with two pans that compares the weight of an object with that of standard weights.

Scalpel

A small sharp knife as used by surgeons. Scalpels and their blades are available in many sizes and styles. The blades are a little trickier than ordinary craft knives to replace, but they are generally superior in use.

Scarf joint

A diagonal joint between two objects such that it maximises the surface area and strength of the joint.

Scarify

Scratch with a sharp point. Often a useful way for increasing the grip of an adhesive on smooth surfaces, also a way of encouraging solder

to wet certain metals.

Scissors knurl

A toolpost mounted knurling device that carries two opposed knurling wheels that can be adjusted to squeeze the workpiece. The opposed forces mean the work is not subject to the sideways forces encountered with a standard knurls, allowing easier knurling on lighter lathes.

Scrap view

A drawing intended to clarify a point of shape or construction, but not made to scale or with any particular care. Never scale from a scrap view and be aware that it may be quite inaccurate in how it represents anything other than the point it is meant to highlight.

Scrapbox

A ubiquitous adjunct to any workshop that stores offcuts, recycled materials and rejected workpieces awaiting re-use.

Scraper

A hand tool used for the removal of very small amounts of metal, particularly used to produce precision surfaces by hand scraping. Scrapers may take many forms, depending on their intended use, a triangular cross section is good for scraping inside bearings, while a broad, rounded end is used for flat surfaces. Old files are often quoted as a source of suitable tool steel for making scrapers. In use, the edge of a scraper needs regular attention with a suitable sharpening stone to keep a good edge.

Scraper ring

A piston ring (usually the lower of the top rings) which has the function of scraping excessive oil from the bore of the cylinder into holes linking the ring groove to the inside of the piston. This has the effect of reducing excessive oil build up which might otherwise create drag on the piston.

Scraping

See hand scraping.

Scrapper

Informal term for a rejected workpiece.

Screw

1. An externally threaded fastener that is intended to be inserted into a hole which may be internally-threaded or sized so that the screw creates its own thread (such as a wood screw or a self tapping screw). A bolt is a pin that may be threaded at the end so it can be held in place by a nut.
2. The action of twisting a threaded fastener or component into position.

Screw cutting lathe

A lathe that possesses a leadscrew for moving the saddle that is geared to the mandrel. Such a lathe can produce a range of gear threads by a process of generation, the accuracy depending almost entirely on that of the leadscrew.

Screw pitch gauge

A gauge with a series of metal blades profiled to match each of a series of screw threads. The gauges can be use to test the pitch and thread form of a screw.

Screw plate

A flat, hardened metal plate with numerous screwed holes, used for forming small threads on relatively soft metal. Much used in watchmaking where the sizes are too small to make the use of conventional dies practical.

Screw thread

A helical groove intended to facilitate the attachment or adjustment of suitably sized of mating parts. Screw threads are classified according to their diameter, pitch and thread form, commonly encountered series of screw threads include metric fine, metric coarse, BA, Whitworth, BSF, Model Engineer, UNC, UNF, acme and BSB, but there are many more.

Screw thread micrometer

A micrometer with pointed anvils for the precise measurement of the root diameters of screw threads. Of little application outside the mass production of screw threads, as small numbers of such fixings can usually be checked simply by matching them to a suitable nut.

Screwcutting

The process of generating screw threads using a lathe. In brief a suitable form tool is advanced into the workpiece and moved along it at a rate fixed by a series of change wheels between the mandrel and the leadscrew. The exact gears required depend on the relation between desired screw pitch and the pitch of the leadscrew.

Screwdriver

A hand tool with a straight or shaped tip that engages with the head of screwed fasteners for the purpose of tightening or removing them.

Scriber

A marking tool with a hardened, sharp point used for marking out.

Scribing block

A solid base with a moveable hardened point that may be used for making off heights or as a reference point.

Scroll chuck

A Self-centring chuck that uses a horizontal plate bearing a spiral thread to move its jaws.

SDS (SDS plus)

A quick fitting system for holding drills based on a standard shank size, used on many portable drills but rarely used for engineering applications.

Seamed tubing

Tubing made by rolling flat sheet metal into a cylinder and welding or brazing it.

Seamless tubing

Tubing that has been made by drawing metal through a die, generally more accurate than seamed tubing.

Seasoning

The practice of ageing cast iron by leaving it out of doors for a considerable period to subject it to changes of temperature with the

weather and time of day. Seasoned castings are more dimensionally stable than ‘green’ castings.

Seat

The surface on which another part rests or seals e.g. Valve seat.

Second

1. The basic SI unit of time, one sixtieth of a minute.
2. In angular measure, one sixtieth of a minute of arc.

Second cut file

A file with moderately coarse teeth. A good general-purpose file for metal removal and shaping, but not suitable for fine finishing.

Second tap

A tap with a fair amount of lead, used to follow a second tap and prepare the way for a plug tap.

Section

1. An engineering drawing depicting a ‘slice’ though an object.
2. A reference to the shape of bar stock such as ‘rectangular section’ or ‘I-section’.

Security

Resistance to movement or slipping. Work should always be clamped securely in place, as if it moves when being cut there is always a danger it will do so in a way that makes the situation worse, not relieve the cut. At best the outcome can be spoiled work or broken tools. A useful tip when wishing to prevent items slipping when bolted down to a hardened worktable is to place a sheet of clean paper between them. Paper is made to an accurate thickness and provides considerable extra grip.

Segment

A section of a circle outlined by an arc and two lines joining its ends to the centre of the circle; the shape of a slice of pie.

Self-act

Automatic feed on a lathe, derived from the rotation of the mandrel, usually via a gearbox or a series of change gears. Most lathes with self-act will take cuts down to about 0.003” (0.08mm) per revolution. Screw cutting may also be taken under self act.

Self-centring chuck

A chuck with a number of jaws which move radially in unison by virtue of engaging with a flat spiral screw on a moving plate within the body of the chuck. Depending on cost such chucks may centre work accurately, but old or cheap chucks should be tested for accuracy. Where a chuck is of questionable accuracy the practice of machining at one setting should be followed whenever possible. The three-jaw self-centring chuck is the most commonly encountered design of lathe chuck, but designs with other numbers of jaws, commonly four and six, are available.

Self-locking nut

A nut with a nylon (originally fibre was used) insert at the top which causes it to lock in place and resist loosening under vibration.

Self-steering

The tendency of a wheelset to follow the track on which it runs, rather

than being guided by its flanges. This is achieved by the use of a suitable wheel profile.

Self-tapping screws

A hardened steel screw with a sharp-edged thread form (sometimes notched to form a cutting edge and flute) that cuts its own thread when torqued into a pilot hole. Mostly used to assemble sheet metal fabrications. The notched-thread design is often used for screws intended for use with plastic.

Sensitive drilling machine

A light pillar drill with the feed arrangement such that the operator can apply feed gradually and get tactile feedback (feel) on the progress of the drill.

Servo motor

An electrical motor whose speed or position can be accurately controlled through a feedback loop using suitable sensors.

Set

1. The alternating deflection of the teeth of a saw in order to make the kerf rather wider than the saw blade, in order to prevent clogging and jamming.
2. Of an adhesive or resin, harden or solidify.
3. Permanent distortion of an object stretched beyond its yield point.

Set screw

A screw for adjusting or clamping parts of a machine.

Set square

A drawing aid, a template with a number of accurately formed angles. Not to be confused with an engineer’s square.

Setting

The accurate positioning of workpieces and tools prior to cutting metal.

Shaded pole motor

A type of induction motor often used in light electrical equipment. The ‘shaded pole’ is created by cutting away or replacing with a copper insert) part of the central rotor in order to ensure it always starts in he same direction.

Shaft

A rotating component, usually bearing a load or transmitting power.

Shank

The ‘safe’ end of a tool by which it is held or mounted, in contrast to the ‘business end’.

Shaper

A machine tool that operates by reciprocating a tool across a stationary workpiece. Now generally replaced by milling machines, the shaper is slow but unrivaled in its ability to produce accurate plane surfaces to a high degree of finish with simple easily maintained tools.

Sharp

Acute; describing a keen cutting edge.

Sharpening stone

A block of abrasive material, often fine grained natural stone but also synthetic materials, in various grades used to sharpen and hone the edges of cutting tools.

Shear

A load applied across the cross-section of an object, a cutting force. (2) A cutting blade, a device for cutting such as bench shears. (3) A cut or break across a component.

Shear brake

A machine for the cutting of sheet metal, similar in principle to a paper cutting guillotine, though more robust.

Shear load

A sideways load on a component such that the forces involved act in

opposite directions across its cross section. Imagine a rivet through two metal plates being pulled apart at their ends. The force trying to cut across the rivet is a shear load.

Shears

The bearing surfaces of a lathe bed, typically separated by a longitudinal gap.

Shed

1. Colliqual term for a workshop in a stand alone building.
2. Building for storing locomotives.

Sheet metal

Metal supplied as large flat plates rather than the form of shaped bars or castings. The thickness of sheet metal may be quoted in imperial or metric measurements or in standard wire gauges. High quality thin metal sheet is referred to as shim stock. Sheet metal may be supplied in varying degrees of hardness making it suitable for different purposes.

Shell endmill

An endmill with an internal bore intended to be attached to an arbor rather than held in a chuck.

Shellac

Flakes of the resin (lac) of certain south Asian trees. It may be dissolved in methylated spirits to make a fast drying varnish (as used for French polish).

Shew

Archaic variant of show, conventionally used on Great Western Railway drawings and those of some other venerable engineering firms. Sometimes found in articles describing models of GWR subjects.

Shim stock

Thin sheet metal to an accurate thickness and good surface finish, typically used for making spacers to allow fine adjustment of assembled parts.

Shock

The sudden application of a force.

Shock load

Describes the effect of instantly applying a load to a system, rather than gradually speeding it up. Shock loads of a given size tend to be more damaging than a constant load of the same size, especially if they are repeated, such as the situation when making an intermittent cut in a lathe.

Shoe

A plate for bearing a load, such as a brake shoe.

Shop

Abbreviated form of machine shop or workshop. A familiar term typical in industry but more common in North America than the UK when referring to a modellers' 'den'.

Shot

Small metal pellets.

Shot blasting

A technique for mechanically cleaning metals by spraying them with metal pellets under pressure. Shot-peening is a variant used for surface hardening of metals.

Shot-peening

A technique for surface hardening metal by shot-blasting it with small, hard metal pellets.

Showman's engine

A traction engine used for hauling fairground rides between venues and to provide electrical power for the rides. Often highly decorated.

Shrink fit

A fit between two parts such that the inner overlaps the outer by so much that the outer part has to be heated (or the inner cooled) to

allow them to be mated. For a 1” (25mm) diameter shaft in a dead-size hole the shaft should be 0.002” (0.05mm) oversize.

Shrinkage

The amount by which a casting decreases in size on cooling. Patterns for castings should be made oversize to allow for cooling (noting that cavities will also shrink). The amount of shrinkage depends on the metal, being quite small for cast iron and much greater for aluminium alloys, for example. Pattern rules are available that allow for such shrinkage.

Shuttle

A piece of a mechanism that moves rapidly back and forth, especially with regard to a loom, but it could also refer to part of a valve, for example.

Side and face cutter

A circular milling cutter resembling a robust slitting saw but with the cutting teeth around the sides of its disc as well as its periphery.

Sight glass

A clear window or tube arranged so as to make the level of a liquid in a container visible, such as water in a boiler or oil in a gearbox.

Silica

Silicon dioxide, the main component of sand and of glass.

Silicon mould casting

A technique for producing multiple items in low melting point metals using re-usable moulds formed of silicon rubber.

Silicon rubber

An artificial substance with great resilience combined with resistance to elevated temperatures.

Silicone

A class of polymer compounds that are based on chains of silicon atoms, rather than carbon atoms. Some silicones are liquid or waxy at

normal temperatures and are used as lubricants or polishes. Longer chain silicones form waxy or rubber like solids. Typically, they have greater resistance to high temperatures than plastics or rubbers and are less liable to perish, a useful property for gaskets, seals or other items exposed to steam. Silicon rubber is used to make moulds for casting some metals.

Sill (cill)

Horizontal member at the bottom of a door, widow or similar. The stone across the step at the upper end of a canal lock.

Silver brazing

A term sometimes used to describe silver soldering to highlight the difference with the use of lower temperature silver bearing soft solders.

Silver soldering

Hard soldering using a molten filler metal with a significant silver content. Silver soldering requires the parts to be joined to be well fitting, with a suitable small gap to allow the solder to flow into it by capillary action. A suitable flux should be used to prevent oxidation of the surfaces to be joined. Following brazing the flux and the work in general can be cleaned off with a suitable pickle. Not to be confused with the use of lower melting point soft solders with a more modest silver content.

Silver steel

A high-carbon steel suitable for hardening and tempering in water or brine, normally available precision ground to within tight tolerances. Silver steel is ideal for the manufacture of small cutting tools, as it is easily worked and hardened without special equipment.

Silversmith

A craftsman skilled in the working of precious metals, particularly in the context of jewellery, tableware and the like.

Sine table

A jig for producing accurate angles using the principles of trigonometry. The sine table has two cylindrical cross pieces an exact distance apart fixed below its table. If one cylinder is raised by a

known amount a triangle is created, where the sine of the angle of the table is given by the height the opposite cylinder is raised over the centre distance of the cylinders (hypotenuse). As slip gauges of very accurate sizes can be used, this generates accurate angles.

Single acting engine

A reciprocating engine in which the working fluid acts on only one side of the piston.

Single cut file

A file with a single series of teeth at an angle of about 25° to its length.

Single-flute

A cutting tool with only one cutting edge and a single flute for clearing swarf. In the case of d-bits or single flute drills the remainder of the periphery of these tools functions to keep them aligned in their hole.

Single-phase

An AC electrical supply with a single line (live) conductor that alternates its polarity relative to the neutral conductor. Most domestic supplies are single phase, nominally 230V RMS and 50Hz. The national grid is a three-phase system. Typically, domestic supplies are produced by splitting the three-phase distribution at local sub-stations.

Sintering

A process resembling casting, but where the mould is filled with a powder that is then subjected to heat and pressure to cause the particles to fuse and make a solid part. Sintered parts are typically porous; an example would be sintered bronze oilite bearings.

Siren

A device for making a loud warning sound, originally in the form of a radial rotor spinning inside a perforated cylinder, but now often electronic.

Size

The magnitude of something. (2) A liquid that when painted on a

surface dries and acts to seal it and make it less porous.

Sketch

A drawing that has not been made accurately to scale, often hand drawn. Sketches can be invaluable in deciding how best to construct a device, or in illustrating particular points, but they should never be scaled from or used as a literal source of dimensions and angles.

Skid

A wooden or metal beam on which an object can be moved over relatively smooth surfaces.

Skin

A thin, tough layer on the surface of a casting, not to be confused with a case. Even well annealed castings can have a tough skin and it is not a defect. It is often most easily removed by taking a deep enough cut to reach the softer material beneath, as light or rubbing cuts can rapidly blunt tools. Even machinists who normally prefer HSS tooling often find it useful to have some carbide tooling just for cleaning up castings in this way.

SLA

Sealed lead acid, a type of lead acid battery that requires no maintenance beyond normal charging.

Slag

Non-metallic waste material, such as oxides and impurities that separate out from metal or alloy during smelting.

Slat

A strip of wood or metal.

Slave chuck

A special workholding device that can be repeatably mounted in a larger master chuck, allowing different operations to be carried out while maintaining concentricity.

Sleeve valve

A rotary valve that surrounds the cylinder of an internal combustion engine. Sleeve valves are notoriously complex and require to be made to high tolerances, however, multi-cylinder radial sleeve valve engines were among the most powerful aircraft piston engines ever made.

Slide

A moveable element of a machine tool used for accurate positioning and movement of tools or work pieces.

Slide valve

A common form of steam engine valve in the form of a block with a central cavity that moves over a flat face, pierced with three ports. The valve rod reciprocates the valve, uncovering first one outer steam port and then the other, whilst connecting the central exhaust port to the opposite steam port. The outside admission arrangement ensures that the steam pressure holds the valve against the port face.

Slideways

Bearing surfaces of a machine tool designed to allow the linear movement of various working parts, such as the cross-slide of a lathe. The typical design for slideways is in the form of two mating dovetails with or without a gib-strip. There are many other effective arrangements which can suit different purposes, notably the flat, round, prismatic and vee-bedways used of various types of lathe.

Sliding fit

A class of fit used where one part must move back and forth within another without excessive friction, but with a high degree of axial location. A closer fit than a running fit. For a 1” (25mm) diameter shaft in a dead-size hole the shaft should be 0.00075” (0.02mm) undersize.

Slip gauges

Gauge blocks.

Slip rolls

A device using adjustable parallel rollers for making large radius bends in sheet metal or bar. There are two arrangements for the rollers. One is for a moveable roller to ‘push’ the metal down between two other rollers, in the other the metal is fed between two rollers and

deflected by a third roller. The second arrangement is generally considered superior, especially where bends have to be made right up to the ends of a sheet. Bends (even tubes) approaching the radius of the rollers can be made with slip rolls, the upper roller normally being removable to allow such work top be extracted.

Slitting saw

A circular cutter, normally very thin in relation to its diameter. Usually held by an arbor.

Slocombe drill (slocumbe drill)

A centre drill.

Slop

Significant free movement in a joint. Generally describing excessive free play. There are times when it may be introduced deliberately, such as in a linkage which must be free to move back and forth to a degree so only a deliberate movement results in actuating the link.

Slot head

A style of fastener with a single straight slot for the insertion of a screwdriver.

Slot-drill

A two-flute milling cutter for the production of accurately sized slots. Slot drills have one flute that cuts to the centre so they may be plunged into a workpiece like a twist drill but creating a flat bottomed hole. They can also cut across the whole of their width, unlike endmills whose geometry results in poor finish and inaccurate slots if used in this way.

Slotting saw

A small slitting saw primarily for purposes such as slotting screws but also useful for general purposes, especially with smaller machines.

Slotting tool

A device, usually hand operated, for reciprocating a small tool with a cavity in order to produce narrow slots, such as keyways.

Small clearance fit

A class of fit suitable for allowing a moving part to pass through a stationary one without depending on it for location. For a 1” (25mm) diameter shaft in a dead-size hole the shaft should be 0.005” (0.12mm) undersize.

Smelting

The process of melting metal in order to refine it and/or cast it.

Smooth file

A file with small teeth giving a smooth surface finish.

Snifting valve¬

A valve designed to admit air into a system in order to prevent the build up of any undesired vacuum. Named for the noise they typically make.

Soak testing

The testing of electrical equipment by allowing it to run so that it attains and holds its normal working temperature for a long time. A useful way of detecting faults which only manifest themselves after a period of operation, or of ‘weeding out’ heat sensitive parts.

Soaking

The process of keeping a metal at prolonged high temperature, as in the malleablising of iron.

Socket screw

A fixing that has a cylindrical head with a shaped cavity for a suitable tool such as a hex key or torx key.

Sodium hydroxide (NaOH)

A strong alkali that attacks aluminium and glass and can be used to remove grease; also known as lye or caustic soda.

Soft

Yielding easily to pressure.

Soft jaws

Plain chuck jaws (usually of unhardened steel) that may be easily machined to hold thin or awkwardly shaped parts.

Soft solder

Filler metals with relatively low melting points for metal joining. Typically containing chiefly low melting point metals such as tin, lead and bismuth, soft solders are literally softer and weaker than hard solders.

Soft soldering

The joining of metals using a molten filler metal with a relatively low melting point (typically below 300˚C). The most usual soft solders are lead/tin alloys such as the 60/40 solder used for electrical work in the past, and which is an excellent general-purpose solder that wets and joins most copper and steel alloys well. Recent regulations now mean that slightly higher melting point lead-free solders must be used for electrical purposes. Other readily available soft solders include a 99%tin 1% copper solder principally meant for potable water supplies. Soft solders must be used with a flux to clean off, and prevent the formation of, surface oxides. For electronic work various mild fluxes are necessary (as through cleaning is not always practical). For other work more aggressive fluxes can be used, but the risk of corrosion if cleaning is not complete should be borne in mind.

Soft-faced hammer

A hammer with nylon, lead or copper faces so it can be used with less risk of marking the work.

Solder chuck

A temporary arrangement whereby a thin layer of soft solder is used to fix very small or thin workpieces in place for machining. The best technique is to sweat the piece into place. Turner’s cement is an old fashioned, and possibly superior, alternative.

Soldering

The joining of metals using a different filler metal with a lower melting point. Contrast soft soldering with hard soldering.

Soldering iron

A heating tool used for soft soldering. Large copper irons heated by a blowtorch or other heat source are now rare. Small gas-heated irons, often suitable for detail work are easy to obtain, as are heavy-duty bits that fit directly on gas torches. Most modern soldering irons are electrically heated. These may range from the very small (12 watt) to the large (300 watt or more). Electric irons generally have replaceable bits. Typically, smaller bits and irons are used for electronic and detail work, larger items may be used for soft soldering items such as sheet brass fabrications.

Solenoid

An electromagnet used to generate motion.

Solid

A state of matter. Solids are rigid and keep their shape.

Solid carbide tooling

Cutting tools made entirely from sintered carbide.

Solid solution

A combination of one element ‘dissolved’ throughout another element, though remaining in the solid state.

Solidus

The temperature at which a cooling non-eutectic liquid mixture will become wholly solid. Between the solidus and the liquidus the mixture will be a pasty combination of solid crystals and liquid.

Soluble oil

A special oil used as a cutting lubricant dispersed as an emulsion (rather than being dissolved) in many times its volume of water - “suds”.

Sound

Audible vibration of the air.

Southern Federation of Model Engineering Societies

The ‘Southern Fed.’ one of the two main groupings of model engineering societies in the UK.

Southern Railway

The Southern was the pre-grouping railway serving the south-east and south coast. It was notable for pioneering electrical traction on a large scale.

Spade drill

Spearpoint drill

Spark eroder

A device for removing metal using repeated high-energy sparks. A simple spark eroder uses a high-current supply of a few tens of volts and a moving electrode (of carbon, brass or some other conductive material) rapidly brought in and out of contact with the work. This may be done in air or submerged under a suitable non-conductive liquid. Such simple devices may be used to remove broken taps or create non-circular holes. More advanced machines using moving wires may be used to cut complex shapes from metal sheet under computer control.

Spark Erosion

A technique for making holes in solid metal using a vibrating electrode under a dielectric fluid to generate high-voltage sparks that ‘erode’ the workpiece. Shaped electrodes can be used to make holes with a good degree of precision.

Spark plug

A device fitted in the cylinder head of spark ignition engines comprising and insulated central electrode and one or more peripheral electrodes

Spearpoint drill

An early design of drill made by forging the end of a piece of carbon steel rod to a diamond or spearpoint shape (when red hot). The end is

then ground to a pair of cutting facets, the tool hardened and tempered, and finally stoned to a high finish. Lacking flutes, such drills do not clear themselves well, but they resist jamming and can be easily made in any required size.

Specific gravity

The density of a material compared to water, which is conventionally assigned a specific gravity of 1.

Speed

Is the rate of change of distance, but without a specified direction (as in velocity) and also with reference to rotation the speed at which a shaft rotates. It is also used in reference to the rate at which a process happens.

Speed control

Many machine tools have stepped pulleys to allow changes in speed, but ideally some form of stepless speed control is desirable. There are mechanical ways of achieving this such as variable diameter pulleys, but usually some form of electronic speed control is used. Simple universal motors, as in power drills, can be controlled with phase angle controllers, like a dimmer switch, but these are not suitable for more powerful machine tools. Many smaller lathes and milling machines use DC motors that lend themselves to fine speed control. For larger machines with three-phase motors variable frequency drives are used.

Speedometer

An instrument for measuring speed.

Spherical turning

A generating process, normally using a pivoted tool arrangement of varying complexity, for making spherical objects. Other ways of turning spheres and balls are the use of form tools and co-ordinate working.

Spindle

A rotating axle or mandrel, usually the heart of a machine tool.

Spinning

The art of cold-working flat plates (blanks) of malleable metal into hollow three-dimensional shapes by pressing on them as they spin in a lathe. The material must be well annealed and the spinning is done using a tool with a blunt, polished tip well supported on a rest. The metal may be shaped freehand, but is more usually shaped onto a former. A skilled spinner is able not just to shape the metal, but to actually move metal around and thicken thin sections of the material.

Spiral fluting

Flutes that twist around the length of a toolbit, such as a twist drill.

Spiral tap

A tap with spiral flutes that has better swarf clearing properties for use under power.

Splash lubrication

An arrangement for distributing lubricating oil that depends on moving parts splashing in a sump.

Splice

A technique for joining or finishing the ends of rope, belting or other cordage.

Spline

A raised axial ridge along a shaft or on the inside of a mating bore. One or more splines may be use to allow power to be transferred between rotating parts that can slide along each other.

Split bush

A cylindrical bearing or clamp split along one side in order to allow it to be adjusted for a good fit.

Split collet

A work holding device that surrounds the workpiece (or a tool) and is then drawn into an internal taper causing it to close up and firmly grip the work. Typically collets are made of spring steel, slitted to allow them to close up around the work when drawn into the taper. Collets are generally very accurate, but this is often achieved at the sacrifice of flexibility. Some collets suit only one size of material, for example. The Clarkson autolock collet system is used for holding milling cutters, and is often copied. Another useful collet for model engineers is the ER collet. By varying the slitting pattern these can be made either very accurate or to cover a range of sizes (typically 1mm), they are also suitable for holding unscrewed cutters. Other examples which may be encountered are morse taper collets and many variations of 8mm collets found on small (watchmaking and ornamental turning) lathes.

Split pin

An eyed metal pin made from wire folded back on itself that can be put through a hole in a shaft and bent back to secure other parts in place.

Spoke

A radial member connecting the hub and rim of a wheel.

Spot facer

A round, end cutting tool with a pilot similar to a counterbore, but used to machine flat pads for fixings on the rough surface of a casting.

Spotting

Setting out holes by drilling though matching existing holes, to ensure a good alignment. Usually only used for one-offs or with a hardened jig.

Spotting drill

A stiff, short drill with narrower flutes than normal and a more acute tip. An alternative to centre drills they are more convenient for marking the location of drill holes but cannot be used to prepare work for fitting to a centre. Little used by model engineers but considered superior to centre drills by many who have used them.

Sprag

A wooden or metal block used to lock the wheel of a vehicle.

Spraygun

A paint application device that uses a flow of air to apply paint or other fluids.

Spring

A device for storing mechanical energy or applying a constant force by its controlled and reversible deformation. Examples include coil springs, leaf springs, and torque springs. Depending on their design they may work in expansion, compression or rotation. Provided they are not over stressed, a spring will deform linearly with applied load and return to its original shape when any load is removed. The characteristics of a spring depend on their design, dimensions and the young's modulus of the material of which they are made. Typical materials for spring manufacture include carbon steels, stainless steels and phosphor bronze. For compound leaf springs, materials such as paxolin may be used to replace some leaves and reduce their stiffness.

Spring balance

A weighing device on which the object to be weighed is suspended on a spring and a reading taken directly from a pointer against a scale.

Spring callipers

Callipers that use a screw and nut in opposition to a spring to set them. They are easier to set accurately than friction callipers, but slower.

Spur gear

A gear wheel with teeth arranged radially around its periphery. The production of spur gears by milling teeth is relatively straightforward using either commercial cutters or home made ones together with some form of dividing appliance.

Square

1. A shape with four equal sides and four corners all of 90°.
2. Positioned accurately at 90° to another object, or in the case of a complex structure with all its components parallel or at 90° to each other.
3. An engineer's square, an angle-checking device with a thick shank and narrow blade set accurately at 90°.

Square file

A file with a square cross section.

Squirrel Cage Motor

A style of electrical motor made with an open frame, now infrequently encountered as closed cases are generally preferred for safety reasons.

SR

Southern Railway. One of the four large companies established as a result of the inter-war grouping of the many small railway companies.

Stability

1. Resistance to falling over, provided by a wide base in relation to the height of the centre of gravity of an object.

2. The resistance of a compound or preparation to degradation.

Standard

1. An upright column or member supporting the upper parts of a machine tool or engine.
2. A fixed, accurate and precise definition of the absolute magnitude of some physical quantity, or a physical object made to replicate such a quantity. A standard of length might be the distance between two marks on a precious metal bar or a number of wavelengths of light of a specific colour. International standards are used as the basis for propagating lesser standards right down to the rules and other measuring tools we use in our workshops. When necessary we may create our own standards, for example one might make a standard angle gauge to use whenever one turns a taper cock for a valve to match a home-made taper reamer.

Standard gauge

The full-size railway standard of four-foot eight and one-half inches between the rails.

Standard wire gauge

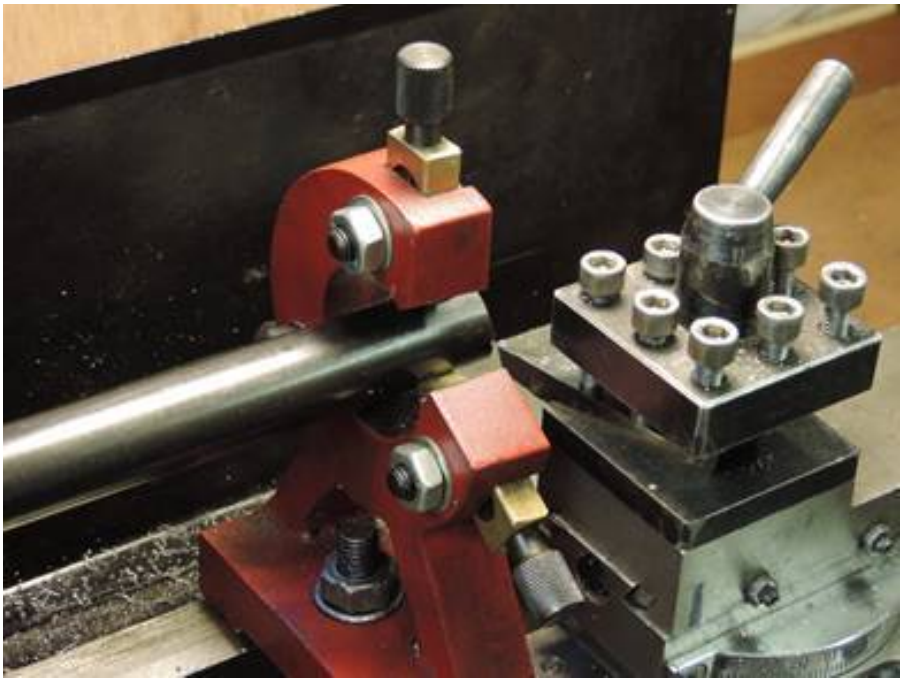
A system for specifying the diameter of wires. The numbers relate to the number of dies through which the metal has been drawn, so the larger the number the finer the wire. It is also used for sheet metal, although the latter is now usually stocked by actual thickness.. Care should be taken not to confuse American and British wire gauges, as they are not equivalent.

Static friction

The resistance to movement of two stationary surfaces. Normally significantly greater than the dynamic friction once the surfaces start to move, it is often loosely described as ‘stiction’.

Steady

A device for supporting work in a lathe that may either be fixed to the bed or follow the work on the saddle.



Steam

Water vapour. Strictly speaking wet steam is water vapour in equilibrium with boiling water, at a temperature of 100C at normal atmospheric pressure, but hotter at higher pressures. Dry steam is the gas phase of water above the equilibrium temperature for a given pressure.

Steam chest

A cavity within the body of a steam engine that stores live steam close to the inlet valves. In a slide valve engine the valve is normally contained within the steam chest.

Steam engine

A heat engine that uses water vapour or superheated steam as its working fluid.

Steam lorry (waggon, wagon)

A load carrying road vehicle powered by steam.

Steam pipe

A pipe for delivering steam. In full size practice all but the smallest steam pipes are normally lagged with an insulating blanket.

Steam tight

Sealed so that steam cannot escape.

Steel

The generic name for alloys of iron (other than cast iron). Plain steels contain only iron and carbon, typically from 0.1 (mild steel) to 2% (carbon steel). Stainless steels contain various other metals to give them corrosion resisting properties. High speed steels may contain large amounts of other metals and have the property of retaining their

hardness at high temperatures making them ideal for cutting tools. Other alloy steels have a huge range of properties from machineability through ductility to high strength, depending on their constituents.

Steeple engine

A steam engine in which the crankshaft and flywheel are above the cylinder, and the piston rod is nevertheless arranged to drive the crankshaft from above via a crosshead running in a tall ‘steeple’.

Stem

The long shaft of a poppet valve

Step brazing

When fabricating complex structures in several stages it is possible to use the technique of step brazing. Essentially the process depends on using a series of filler metals of different melting points at each stage, so that the heating for later stages does not result in the melting of earlier joints.

Step drill

A drill in the form of a stepped cone with straight or spiral flutes. It is used for drilling holes in sheet metal. Due to the large increase in diameter between steps the work needs to be held firmly and supported by backing material to prevent distortion.

Step drilling

A technique of starting with a small hole and enlarging it in multiple stages used where the available machine power or the delicacy of a component mitigates against drilling a hole in one pass. Sometimes a small drill will be used to accurately locate a hole, before finishing with a larger drill. When an accurate hole is needed and a reamer is not available another approach is to drill a hole a little smaller than finished sized, then run through a sizing drill to finish.

Stephenson valve gear

A simple but effective form of valve gear used on many locomotive, marine and stationary steam engines. It uses two eccentrics one set for full forwards gear, the other for full reverse, whose motion is combined using an expansion link.

Stephenson. George

The designer of Rocket, the revolutionary steam locomotive.

Stick welder

Informal term for an MMA or ‘arc’ welder.

Stiction

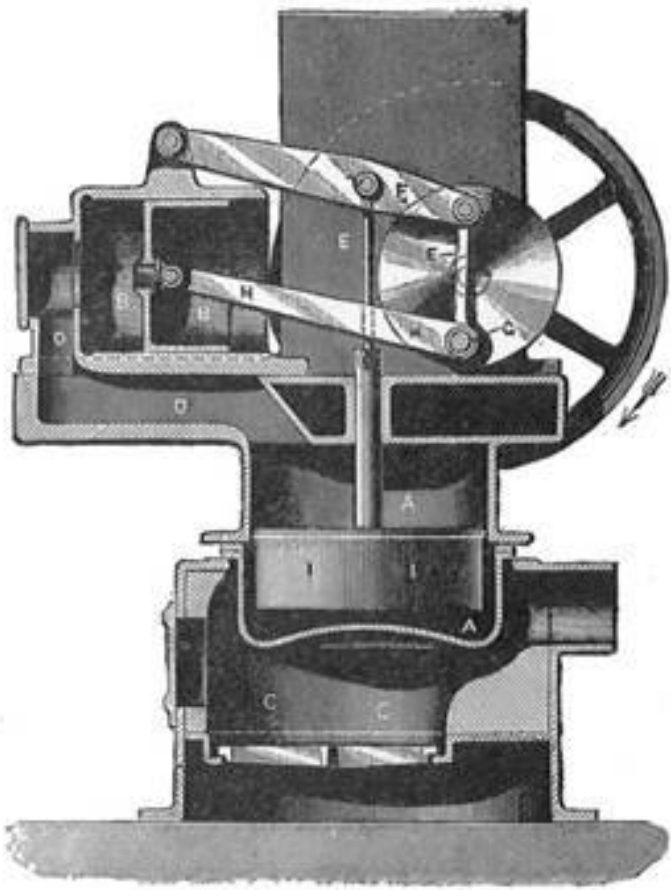
An informal term for static friction, particularly for systems where considerably greater force has to be applied to start the system moving than to keep it in motion. Debatably a combination of ‘sticky’ and ‘friction’, rather than a contraction of ‘static friction’.

Stirling cycle

The operating cycle of a Stirling Engine.

Stirling Engine

A hot air engine having two pistons approximately 90° out of phase. One of these is a loosely fitting, large displacer piston that moves the air between the hot and cold ends of its displacer cylinder. This causes cyclical expansion and contraction of the air which creates motive force by acting on a closely fitted power cylinder.



Stirling. Revd. Robert,

The inventor of a greatly improved heat engine with a closed cycle, which used a regenerator to achieve a practical level of efficiency. Stirling cycle engines can demonstrate higher efficiency than internal combustion engines, but though simpler they are heavier for a given power output, mitigating against their general use.

Stochiometric ratio

The minimum ratio of air to fuel required to achieve complete combustion of the fuel. The concept is important with reference to the tuning of internal combustion engines for optimum efficiency, though

its application to small cylinders where combustion is generally incomplete and inefficient is largely academic.

Stop

A fixed or adjustable attachment to a mechanism to prevent movement past a certain point. Stops are particularly useful when carrying out a repetitive process, as they remove the need to watch the dimensions of the cut each time.

Stop valve

A valve whose function is to prevent or allow the passage of a fluid, with good tight closure being a priority over any fine control over the flow rate essentially acting as a on/off switch.

Strain

The amount by which a body stretches or compresses under a load. For example, if a bar is pulled it becomes longer (longitudinal strain) and narrower (lateral strain). See Poisson's ratio.

Strand

A single filament of a rope or cable.

Stress

The load on a part, expressed as the force per unit area. It is therefore in the same units as pressure and the imperial unit is pounds per square inch. This force may be in tension (Tensile stress) or compression (compressive stress). The SI units are pascals or megapascals, though newtons per square millimetre may be encountered.

Stress fracture

A crack that has arisen because of the forces applied to a part. The usual cause is fatigue caused by the cyclical application and removal of stress loads. Cracks often propagate from defects or sharp internal corners that act as stress raisers.

Stress raiser

A feature, such as an acute internal corner that creates a local concentration of stress forces when a component is loaded, greatly

increasing the risk of local cracking and failure. Stress raisers should be avoided in any component subject to high or repeated stress.

Stress-strain curve

A graph of the elongation per unit length (strain) of a material against the applied force per unit of cross section (stress). This curve define the behaviour of a material under load and can be used to discover its proportional limit and elastic limit, its yield point and its ultimate tensile strength. While it is not practical for a model engineer to make complex calculations using all of these properties of a material, a knowledge of their definition is an aid to comparing materials and selecting the best one to use for a critical task

Stretcher

A cross-member holding two frames apart, particularly the frames of a locomotive.

Stroke

The distance a piston travels along its cylinder between top dead centre and bottom dead centre. It is normally equal to twice the throw of the crankshaft.

Stub drill

A short, rigid drill bit, more robust than a jobber's drill.

Stub mandrel

1. A short mandrel, normally only supported at one end.
2. Pen name of author on hobby engineering topics, of dubious authority.

Stub-gear

A gear with teeth having a reduced addendum and dedendum, making them proportionately stronger and reducing undercutting on gears with few teeth.

Stud

A fastener threaded on both ends, intended to have one end inserted into a blind hole, and have a nut fixed at the other to hold a component in place. In effect it is a screw at one end and a bolt at the other.

Studding

Continuously threaded metal rod in various sizes. It may be cut to length to form crude studs and other custom fixings.

Subject

The full size object a model represents. For some this may be as vague as 'a horizontal engine', others may choose to model a particular machine at a particular time (or even moment) in its history, and spend a great deal of effort on background research into the subject.

Suds

An emulsion of soluble oil in water used as a cutting lubricant. Suds is notoriously smelly, but cheap and effective. In industry, where machines are used on a daily basis, corrosion is not a problem, however, in a typical home workshop situation anaerobic conditions can develop allowing microbial growth and hence corrosion. Increasing the amount of oil is counter productive, as it increases the food supply for microbes. Unless care is taken to completely clean and dry machines, neat cutting oil is probably a better option for many model engineers.

Suds pump

A pump for feeding a constant flow of cutting fluid to a cutting tool.

Sulphur

A soft, yellow mineral with a low melting point. It is sometimes added to steels to increase their machineability (e.g. EN1A).

Sulphuric acid

A very strong acid. Unlike hydrochloric acid it does not produce corrosive fumes at normal concentration's and temperatures, but if splashed it has the property of concentrating through evaporation of water and forming small, very corrosive spots.

Sump

A reservoir for collecting fluid, such as lubricating oil or coolant, at the bottom of an engine or other machine.

Sundial

A device for telling the time by the position of the shadow cast by a pointer (gnomon) on its dial in daylight.

Super Adept

A now obsolete and very basic lathe that provided an inexpensive route into hobby engineering for many people in the mid 20th century,

Supercool

Cool below normal freeing point without solidifying. Supercooling generally depends on an absence of places for crystal formation to start.

Superglue

An informal term for cyanoacrylate adhesive.

Superheated steam

Steam that is above its critical temperature, also known as dry steam. Superheated steam behaves as a true gas, not as a vapour, unlike wet steam.

Superheater

An arrangement to further heat steam after it has been taken from the boiler. Steam direct from a boiler is a vapour in equilibrium with the water in the boiler (wet steam). Superheating has the effect of raising it above the critical temperature, reducing the chance of condensation and (because it increases the temperature differential between intake and exhaust) increasing efficiency. Superheaters usually take the form of a return loop of piping within one of the boiler's fire tubes, or in the firebox. This is a demanding environment, hot, with corrosive gasses and particles present, and the materials and construction of the superheater must reflect this.

Surface finish

The quality of a surface after machining, often described in terms of the size of surface irregularities. These may be either on a short scale (roughness) or a longer one (waviness). A typical ranking of some machining processes in terms of quality of finish might be hacksawing, filing, turning/milling, scraping, grinding, honing, lapping. It should be borne in mind that there is considerable overlap and that the actual finish produced by any process will depend on many factors.

Surface gauge

A device comprising an upright (that may or may not be adjustable) on which a pointed bar or scriber is mounted. Used in conjunction with a surface plate it can be used for comparing or marking out vertical distances. The tip can also be used as a probe, such as when setting work concentrically in a four jaw chuck, for example. A simple but effective aid to machining.

Surface grinder

A high precision tool for the removal of small amounts of material using a grinding wheel mounted above a worktable.

Surface plate

A precision plane surface used as support and a reference for laying out, setting up or making precise measurements. Cast iron and granite surface plates may be obtained made to high standards of accuracy. The original method of production is elegant in its simplicity: three iron plates would be hand-scraped to each other. If each combination of three plates was satisfactory then, by definition all three were flat. For most model engineering purposes, a piece of thick tin-float glass, suitably supported, may be used with a high degree of confidence. Some writers have reported that polished stone tiles serve the purpose well.

Surface speed

The speed at which the surface of a rotating tool or workpiece moves past a stationary point. Calculated as (rpm x diameter x π). It is important as the surface speed will ideally be the appropriate cutting speed for a given tool and material.

Surface tension

A cohesive force aligned with the surface of a liquid. When surface tension is less than the cohesion between a liquid and material, it will wet that material. If surface tension exceeds the cohesion, then the liquid will not wet the material.

Surface treatments

Various techniques for treating tools and parts to produce a hard outer case while leaving the inside tougher and less brittle. Traditionally case hardening has been used and is a process that can be used in the home workshop. Nitriding and coating with titanium nitride are techniques that are less practical on this scale.

Swage

A tool for bending and stretching metal; the process of bending metal into shape. An example could be swaging the end of a section of pipe so it can fit over a second piece.

Swarf

The waste material removed when cutting metal. It ranges from powder like iron filings produced when machining cast iron, through granular chips from free cutting steel and brass, to long curls produced by tougher materials. Care must be taken to avoid injury from flying or whirling swarf. When clearing long pieces use a metal rod to avoid fingers being pulled into machinery. When milling at high speed with a low depth of cut it is possible to produce swarf in the form of very tiny, sharp needles that should be treated with extreme care.

Sweating

A process for joining parts by soldering to fine tolerances. The faces to be joined are tinned and then wiped while the solder is still fluid, leaving a very thin film. The two parts are then clamped together and heated until the solder melts. This leaves a fine joint on cooling. The strength of such joints is often greater than one made with a significant fillet of solder.

Swept volume

The difference in volume of an engine cylinder measured when the

piston is at each end of its stroke; equal to the area of the piston multiplied by the stroke.

SWG

Standard Wire Gauge.

Swing

The maximum diameter of work that lathe can turn (swing) between its centres; twice the centre height of a lathe. The figure usually quoted in the specification of American lathes.

Swiss file

A small file, typically 6-8” (150-200mm) long and normally with a relatively fine cut. Swiss files are available individually and as sets in a wide range of different profiles. Cost reflects quality and the best single files will be more expensive than a whole set of cheap files. The name reflects the use of such files (and smaller) in the traditional Swiss clock and watch making industry. They are often supplied without handles, and if the tang is rod-shaped rather than sharp they may be used for light hand work without a handle, but should never be sued in this way near machinery. Push-fit handles are available to fit such files, as are somewhat oversize handles with a collet that may be swapped between files.

SWL

Safe Working Load.

Symmetrical

Shaped so that it can be divided into two or more identical (though possibly handed) parts.

Syringe

A piston in a cylinder for sucking up and expelling liquid by hand in a controlled manner.

T

Tab

A small flap. Tabs can be a very useful aid to assembling sheet metal fabrications.

Table

Shorthand for the work table of a machine tool such as a surface grinder or milling machine. Typically it will have t-slots for the easy attachment of workpieces.

Table Engine –a steam engine in which the cylinder is mounted above the crankshaft on a horizontal table, typically supported by columns.

Tack

A small sharp nail, to temporarily hold a part in place with adhesive or other temporary fixings.

Tailstock

A movable support opposing the headstock of a lathe, usually containing an extensible quill, sometimes referred to as a poppet.

Tailstock die holder

A device for supporting thread forming dies from the tailstock of a lathe. Although not guaranteeing as accurate a thread as screwcutting, the use of a tailstock die holder is far superior to cutting threads with a standard hand-held diestock. It usually has the same adjustment screws as a diestock. In the absence of a tailstock dieholder, it is sometimes possible to support a standard diestock from the tailstock.

Talc

A fine soft powder. Talc sprinkled on a file can help stop it clogging and assist with getting a fine finish.

Tallow

Animal fat; lard. Historically tallow was used as a grease and a cutting lubricant. The main problem with tallow is its tendency to become rancid and it has been replaced by better smelling lubricants.

Tandem compound

A compound steam engine in which the high- and low-pressure cylinders lie in line with each other.

Tang

The tapered end of a file on which a handle should always be fitted for safe use.

Tangential toolholder

A device used to hold lathe cutting bits, such that they are presented at a tangent to the work. They have the advantage that sharpening usually involves a single grinding action on the end of the bit. Usually used with HSS toolbits they are often a short cut to improved finishes on smaller lathes that are not well suited to most carbide tooling.

Tank engine

A locomotive with an integral water tank.

Tap

1. A forming tool for making internal threads, in the form of a screwed rod with a number of flutes creating a series of cutting edges. Usually a cutting tool (though there is some extrusion of softer metals), but some taps have no flutes and work entirely by an extrusion process.Taps are available in a bewildering range of thread forms. Taper, second and plug taps have decreasing amounts of lead and are used in series to avoid over-stressing the taps. Damage to taps can be further reduced by drilling pilot holes rather larger than the core size of the tap; a drill that gives a 60% depth of thread is generally advised and is virtually as strong as a full thread form. To produce accurate threaded holes a tapping guide of some sort should be used.
2. A valve used to control the outflow of a liquid or gas.

Tap wrench

A device for holding thread forming taps. The common style is a t-handle with various clamping arrangements for gripping the square section on the end of the shank. Some small tap wrenches have collets and hold the tap by its round shank, this can be an advantage when using small taps as they can spin in the collet if overloaded. Tap

wrenches can also be used for turning hand reamers and similar tools.

Taper

A surface machined to part of a cone. A matching internal and external taper can be used to provide accurate concentric and longitudinal positioning of parts. Tapers for tool holding of around 3° are generally classed as self-holding, though it is not unusual for them to have a tang to prevent slippage, or a drawbar for added security. Coarser tapers (such as international taper, R8 or many collet systems) are used in association with some form of positive restraint. Self-holding tapers such as tapers are used on machine tools to provide fittings for cutters, accessories, chucks and the like. The Jacobs series of taper is often used for drill chucks. A taper for locating machine parts may be of any appropriate angle, though about 10° is suitable for many purposes, such as mounting a flywheel. In such case parts are always secured by an additional key, lock screw or similar fitting. Tapers may also be used for valve barrels, pivots and to improve the appearance of otherwise clumsy looking parts such as handles.

Taper drill

1. A conical single-flute drill, used for opening up holes in sheet material to any size within its range. Because these drills have a very steep taper they do not make parallel sided holes. They are

best suited to making holes for electrical controls and sockets in panels and other non-critical applications.

2. (Informally) a drill with a morse taper shank, intended to be held directly in the taper socket of a machine, instead of in a chuck; in larger sizes known as blacksmith's drills

Taper file

A file with a long, thin triangular cross section.

Taper gauge

A go/no-go gauge in the form of a tapered rod or hole that can be used to test the diameter of the large end of a taper, by means of judging how far it can be inserted. If the external taper is smeared with marking blue the part and the gauge can be lightly wrung together, and if the taper is correct the blue should spread evenly over both parts.

Taper pin

A metal (usually hard brass or steel) pin with a gradual taper (often 1:48) used to secure a part to a round shaft. A diametric hole about the size of the small end of the pin is drilled though both parts and then shaped with a taper reamer. The pin is then hammered home and may be finished to length. Such fixings are effectively permanent, but can be disassembled by driving the pin out from its small end with a pin punch.

Taper pin reamer

A slender taper reamer used specifically for making holes for taper pins.

Taper reamer

A reamer designed for finishing tapered holes to a standard size. Larger ones are available for machine tool tapers and smaller ones for taper pins. Depending on the amount of material to be removed the starting hole may be bored near to size (for just light finishing by reamer); step-drilled to an approximate taper; or for small sizes may be a simple straight sided hole. Taper reamers for making valve seats and similar purposes are easily made by turning a suitable cone in silver steel, then finishing it along the lines of a d-bit.

Taper socket

A female taper.

Taper tap

A tap with a considerable amount of lead used when first starting to cut a thread in a hole. For deep holes it is wise to cycle through the taper, second and plug taps in turn, rather than trying to do the entire hole in one go. Some taper taps may cut a thread that is considerably undersize, these cannot be used to finish a through hole.

Taper turning

To create tapered work in the lathe there are three main techniques. These are (1) Offsetting the tailstock so the work is presented at an angle. (2) Turning the topslide to the cut is taken at an angle. (3) Using a taper turning attachment to guide the cross-slide to create the taper.

Tapered

In the shape of part of a cone, a round object smaller at one end than the other.

Tappet

A part interposed between a poppet valve and its cam to facilitate adjustment of the valve action.

Tapping

The process of cutting or forming internal threads using taps.

Tapping drill

The appropriate size of drill to prepare for tapping any particular internal thread. Opinions differ on the relationship between thread core diameter and drill size, but there is some agreement that a hole sized to allow for 60% thread engagement is probably the optimum compromise between thread strength and minimising tap breakage.

Tapping fluid

A cutting lubricant formulated especially for thread cutting operations. Most tapping fluids also serve well for drilling and

reaming.

Tapping guide

A simple jig, comprising a close fitting hole in a square ended block, to help minimise breakage of small taps and also ensure that threads are truly perpendicular to the surface.

Tarnish

Surface discolouration of metal without significant dimensional change due to oxidation or chemical attack, usually reversible by polishing.

T-bolt

A bolt with a head shaped so that it can be fitted into a t-slot as an alternative to using a t-nut and a stud.

TDC

Top Dead Centre, that position of the crankshaft of an engine where the piston is exactly at the top of its stroke. TDC is the main reference point for all forms of engine timing diagrams.

Teak

South Asian tree with dark, durable timber.

Telford. Thomas,

A Scottish civil engineer and architect strongly associated with Shropshire where he built several roads, canals and many bridges.

Tempering

The controlled reduction of the hardness of a material to make it less brittle, increasing its toughness and aiming for a compromise state which suits its application. In the US tempering is often informally used to refer to hardening, and drawing is used to refer to the process known as tempering in the UK.

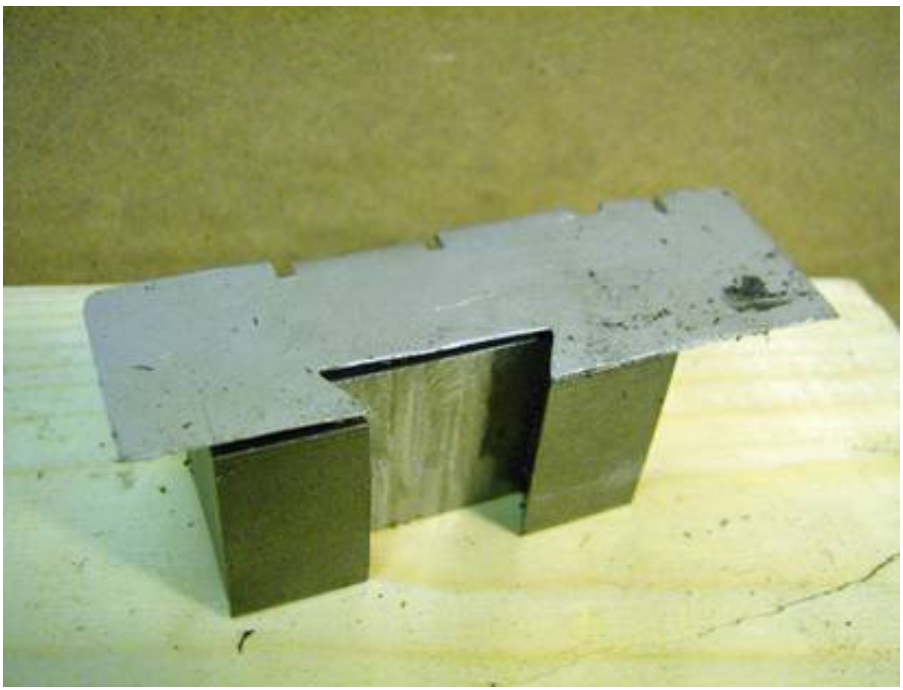
Tempering colours

When carbon steels are heated in the presence of oxygen, a thin oxide film of a thickness related to the temperature forms on the surface.

The colour of this film indicates the maximum temperature reached over a broad range which usefully corresponds to that required for tempering hardened steel for various purposes. For example, springs can be tempered by heating until they show a dark blue colour, whilst many cutting tools only need to be heated until they take on a dark straw colour.

Template

A pattern allowing the easy manufacture or matching of multiple objects. Unlike a jig, a template is use to mark or check shape or guide a cutter, not to hold the work.



Tender

A non-powered special purpose railway vehicle hauled behind some steam locomotives to carry their water and coal supplies.

Tender engine

A locomotive that does not carry its own fuel or water, but instead pulls a tender carrying these supplies.

Tension

A pulling stress on a component due to a load, the opposite of compression.

Tension spring

A spring with its coils made so they touch each other, designed to be used under tension. Such springs usually have an open ring at each end for attachment.

Tesla coil

A two-winding coil which uses a tuned resonance to generate high voltages, comparable to lightning.

Tesla turbine

A compact design of turbine that uses the inward flow of steam (or other fluid) between stacked discs as its driving force. Such turbines can have remarkably high power densities. The working fluid is injected tangentially between the plates and exits through a central exhaust.

Tesla. Nikolai,

A prolific inventor who devised a turbine using parallel discs and capable of extraordinary power densities as well as a spectacular electrical discharge coil.

Thermal expansion

The dimensional change in a material when it is heated.

Thermocouple

A device that measures temperature through the voltage generated when two wires of different metals are joined at each end, and the two junctions held at different temperatures. Unlike a thermometer, which measures absolute temperature, the voltage is proportional to the temperature difference between the two junctions. This disadvantaged is compensated for by a thermocouples ability to measure very high temperatures, near to the melting point of its constituent metals.

Thermometer

A device for measuring temperature. Traditional thermometers use the

expansion of mercury or alcohol, or the differential expansion of metals in a bimetallic strip, but electronic thermometers are now available. Non-contact thermometers that detect infra-red light work at higher temperatures and can be useful in the heat treatment of metals.

Thermosetting plastic

A plastic, such as Bakelite, that sets hard when it is polymerised, and cannot subsequently be re-melted and reformed. Such plastics are more suitable than thermoplastics for structural components exposed to heat.

Thermostat

A device for automatically controlling temperature.

Thickness gauge

A device for measuring the thickness of thin materials, one style has large anvil against which a smaller anvil acts, this arrangement reduces the risk of the sheet twisting and giving a false reading.

Thimble

Any small metal cap, resembling a sewer's thimble.

Third angle projection

An engineering drawing in which each adjacent view is placed as if the object has been rotated through 270°. If the first view is from the front, a top view will lie above it and the right hand view will lie on its right, and so forth. This is the favoured projection in the USA, and it can be argued that is easier to read than first angle projection, as each view lies where it might be expected third angle projection. It is normal to indicate this projection with a small two-view drawing of a truncated cone according to the projection, i.e. Two concentric circles adjacent to the small end of the cone.

Thomas. George H.,

A model engineer known for his very practical and well-finished tool designs notably the Universal Pillar Tool.

Thou

Informal but much used term for a thousandth on an inch, 0.001”

(0.0254 mm).

Thread

A spiral ridge cut or formed around or inside a cylinder as used for nuts and screws. Mating inside and outside threads are universally used for the secure but reversible joining of objects. A multitude of thread forms exist

Thread depth

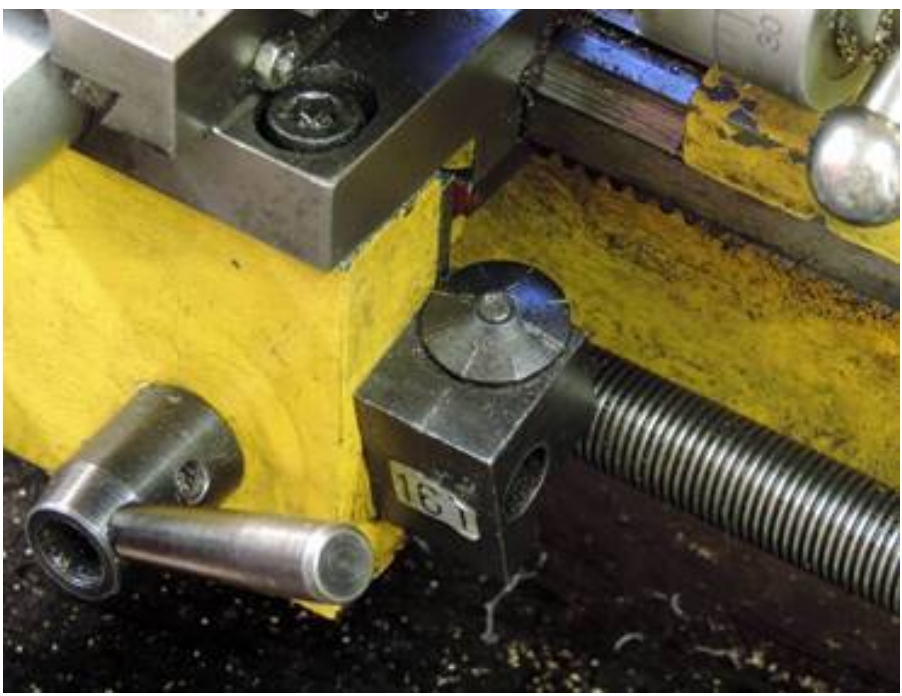
The distance from the crest of a thread to the root, representing the distance that a form tool has to be fed in to the work.

Thread form

The shape of a screw thread, typically characterised by the angle of the flanks of the thread and the flat or rounding of the crests and roots of the thread.

Thread Dial Indicator

A device that counts revolutions of the leadscrew of a lathe to facilitate screw cutting.



Three phase

An AC electrical supply with three line (live) conductors, each with its current flow (relative to the neutral conductor) 120˚ out of phase to the other signals. Normally 450V RMS at 50Hz, three phase supplies can deliver greater power than single phase supplies and are normal in industry. Three phase motors also run more smoothly than single phase motors. Smaller industrial machine tools designed to work on three phase may be operated using special phase converters.

Three view (drawing)

An engineering drawing which comprises views of an object along each of three normal axes, typically an elevation, plan and a side view. The arrangement of the views will depend on the projection used.

Three-dimensional

Having depth as well as height and breadth. Of a drawing, set out so as to give the appearance of depth.

Three-jaw

If used without qualification, shorthand for a three-jawed self-centring chuck.

Three-square file

A file with an equilateral triangular cross-section.

Throttle

A valve controlling the speed of an engine by reducing the bore of a tube and hence reducing its supply of air or steam.

Throw

1. An offset section of a crankshaft with the bearing journal for the rod of one or more pistons.
2. The amount by which the centre of such bearings are offset from the centre line of the crankshaft; normally half the stroke of the engine.

Throw-away cutter

See FC3 end mill.

Thrust

A horizontal force, such as along the axis of a shaft.

Thrust bearing

A bearing designed to take axial loads.

Tick

A small mark against a line in an engineering drawing to indicate a machined surface or a reference face.

Time delay fuse

A fuse designed to allow short transient surges of current that exceed its rating without breaking, but to blow if the current is sustained for longer. These fuses can be useful for equipment such as motors that demand high but brief currents at switch on. They are normally marked with a ‘T’ after the current rating.

Tin

A soft pale grey metal. Used to produce a corrosion resistant plating and in alloys such as bronze and soft solder. Lead free plumbers’ (not electricians’) solder is 99% tin with a little copper added. Tin foil has been superseded by aluminium foil, but tin plate is still available.

Tin plate

Thin sheet steel with a thin layer of corrosion resistant tin plating. Before the universal availability for plastics, tin plate was much used for toys and tins and is still use for making tin cans from which usable sheets can sometimes be recovered. It is easily cut to shape and solders well.

Tinning

Coating a metals surface with soft solder, prior to sweating a joint, or to make it easier to join other parts to it by soft soldering.

Tipped tool

A cutting tool with a hard point brazed or welded to a softer shank.

TIR

Total Indicated Runout, a measure of the concentricity of a spindle or other shaft (such as a rod held in a chuck) to its axis. It can be a useful measure of the quality of a chuck or collet. It may be measured using a dial test indicator or lever gauge against the spindle while rotating it slowly through 360° and taking the difference between the highest and lowest readings.

T-nut

A nut with the cross-section of an inverted ‘T’, used in conjunction with matching studs and t-slots to provide moveable fixings.

Tolerance

The acceptable range in which the size of a part must fall in order for it to fulfil its purpose. Tolerances are essential in mass production, but generally less important for model engineers, where parts are normally made to fit each other. One key exception is when making parts to fit with bought in items.

Tommy bar

A plain metal bar that functions as a handle when inserted in a hole in a tool or other device.

Tool

1. A device designed to facilitate a particular task. There are two main types: hand tools and machine tools.
2. An interchangeable cutter or other toolbit that is fitted in a larger tool.

Tool and cutter grinder

A device which combines a spindle-mounted grinding wheel with a system for accurately presenting tools and cutters to the wheel for shaping and sharpening. Such devices can range from the very sophisticated which allow the sharpening and production of multi-edged tools (such as the Quorn) to simpler devices that facilitate the sharpening of lathe tools and the like.

Tool bit

Interchangeable tools such as end mills, slot drills, twist drills, turning and parting tools that can be fitted to machine tools to allow them to undertake a wide range of tasks.

Tool setting gauge

A jig to facilitate the rapid setting of a tool. Typical examples might be

to set lathe tools to centre height or to align spherical turning tools to the centre line of a workpiece.

Tool steel

A general term high-carbon steel used for the making of cutting tools. In its annealed state it can be easily worked, but when hardened and suitably tempered it make durable tools. It is often used for hand tools such as files and chisels where the usage does not involve high temperature that could draw the temper of the tool. Historically it was used for many tools such as drills and lathe bits which today are almost universally made of heat resistant materials such as HSS and tungsten carbide. Examples of tool steels available to the model engineer are silver steel and gauge plate.

Toolchest

A traditional form of tool storage. Usually a wooden chest with many different sized drawers, often with a diamond-shaped mirror in the lid. Not normally made from oaks as the tannins in this wood can promote rusting.

Toolholder

A device used to hold a tool which may then be either hand-held or mounted in a chuck, toolpost or other support as appropriate to its design. In general, one toolholder may act as an adapter for several tools.

Toolmaker’s buttons

Accurately sized, hardened steel cylinders, with a central hole for a fixing screw, used for laying out centres and locating parts. For example if several holes need to be bored in precise relation to each other, tapped holes at the approximate positions of each hole are made and used to fit buttons accurately in position. Each button is used in turn to accurately centre the work on the faceplate of a lathe or the bed of a jig boring machine (or a mill or high quality drilling machine).

Toolmaker’s buttons

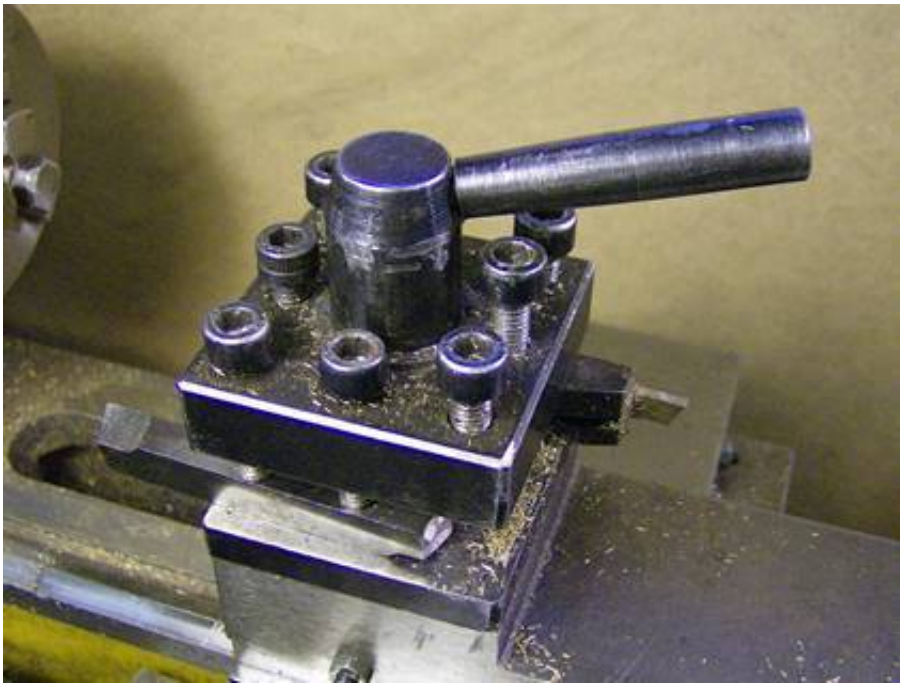
Sized circular washers that can be used to accurately position parts in a jig without having to resort to direct measurement.

Toolmakers clamp

A simple but effective and versatile clamp with jaws made from two bars held together by a pair of screws. The screw closest to the jaws draws them together, and it is used to adjust the clamp to fit the work. The other screw pushes the far end of the jaws apart, tightening them on the work. These clamps are easily made in sizes from the tiny to the huge.

Toolpost

A device on a lathe used to rigidly hold tools in position. Simple toolposts hold a single tool, whilst others can hold several tools. Quick change tool posts are used with interchangeable tool blocks.



Toolpost mill

A milling spindle designed to be mounted in the toolpost of a lathe. This arrangement can allow operations such as cutting keyways, gear cutting (by indexing the mandrel) and thread milling.

Toolrest

A simple ledge or plate used to support a hand-held tool during use or sharpening.

Toolroom

A special workshop within a factory where the most accurate standards and measuring tools are kept as references for those used elsewhere. The toolroom might also test production samples, produce jigs and custom tooling and generally carry out work requiring a greater degree of accuracy and precision.

Toolroom quality

Expression often used by tool suppliers to denote products made to the highest standards of precision and accuracy.

Tooth

One of the cutting edges on a multi-edged tool such as an end mill or a saw blade. (2) A projection on a gear or pulley that engages in the tooth spaces of a mating gear or belt.

Tooth load

The amount of metal removed by each tooth of a cutter as it passes across the work. Calculated as feedrate/(rpm x number of teeth). Hence multi-tooth cutters can remove more material at a single pass than single tooth cutters.

Tooth pitch

The number of teeth per inch (imperial) or the tooth spacing in millimetres (metric) of a saw blade. The larger the tooth pitch, the less a saw will clog and the faster it will cut. One should, however, choose a saw blade which will have at least three teeth in contact with the work at any time, in order to minimise jamming and tooth breakage. Finer tooth pitches also give a better surface finish, which may be an issue if they are not to be machined or finished in any way. For metal cutting 14 tpi (1.5mm) may be considered coarse and 24tpi (1mm) typical for uses such as hacksaw blades. Much finer pitches may be used on razor saws and piercing saws.

Tooth space

The gap between two teeth of a gear.

Tooth thickness

The distance around the pitch circle between the two opposite faces of a gear tooth.

Toothed belt

a flexible drive belt with regular teeth that mesh with matching pulleys. The teeth allow two shafts to be kept in a precise angular relationship with each other (as in a camshaft and a crankshaft) and/or greater power to be transferred.

Top rake

The relief on the upper surface of a lathe tool that, with front rake, creates the wedge angle of the cutting edge. For some relatively soft materials that tend to ‘grab’ a cutter negative rake is sometimes used, which has the effect of lifting the cutter out of, rather than into, the

work.

Top-slide

A moveable part, mounted above the carriage and cross-slide of a lathe and usually bearing the toolholder. Normally aligned with the bed of the lathe it is typically easier to make accurate tool movements using the top-slide than the carriage. It also allows the tool to be moved independently when the leadscrew is engaged for screw cutting. Unlike the other slides, the top-slide can be turned to facilitate the cutting of tapers. When maximum rigidity is required the top-slide may be removed and replaced with a raising block or a taller toolpost directly mounted on the cross-slide.

Torque

1. The twisting force generated by or applied to a shaft about its axis. Torque is an important consideration whenever a component has to sustain a twisting load. The power transmitted by a shaft depends on its speed and the torque. Internal combustion engines generally produce their maximum torque (and power) at high speeds, and generally need gearboxes if they are to work efficiently over a range of output speeds. Reciprocating steam engines produce their maximum torque when stationary, and sustain their power output across a wide range of speeds; this is why steam engines generally do not have gearboxes. Torque is measures in terms of a force and its distance from the axis of the shaft, hence its units are typically pound-feet (meaning pounds force) and joules (newton-metres).
2. The physical action of tightening a screwed fastener by turning it. It will generally be found that if correctly sized tools are used to torque fasteners it is hard to overstress them, however, care should always be taken with smaller fasteners.

Torsion

The distortion of a material under a twisting load.

Torsion spring

A spring in the form of a relatively long bar that carries a twisting load, rather than operating by deflection, notably used in the suspension of both the original Volkswagen Beetle and the Tiger Tank.

Torsional load

A twisting force or torque applied to an object.

Torx key

An L-shaped metal bar with ends of a six-pointed star like cross section used as a tool to operate fasteners via suitable mating sockets. Torx fasteners are more expensive than hexagon socket ones, but can take greater torque without damage. For trademark reasons compatible tools are sometimes marketed under t-star and similar names.

Toughness

A measure of a materials ability to withstand loads and resist wear. There is no fixed measure of toughness, as it depends on the application and covers various properties of a material. Materials that combine different properties, such as case-hardened steel or composites, are often particularly tough.

Tpi

Threads per inch.

Traction engine

A self propelled steam road vehicle used for a wide range of purposes including a tractor (towing vehicle), ploughing engine, portable power source and showman's engine.

Traction motors

Electric motors designed specifically for use as sources of motive power, typically rugged with high torque and able to withstand heavy duty cycles.

Train

A chain of rolling stock pulled by a locomotive.

A series of gears.

Tram

A light rail vehicle designed to operate on ways shared with ordinary

traffic. Trams usually combine motive power and passenger carrying in the same vehicle and have a short wheelbase to allow them to operate within urban areas.

Trammel

Long bar bearing moveable points for laying out large circles and arcs.

Tramming

The process of aligning the spindle of a milling machine or similar tool so that it is normal to the work table in both axes. This is usually done by fitting a dial indicator to an arm in the spindle and taking test readings at points on the table whilst making appropriate adjustments.

Transverse

Crosswise, side to side.

Trapezium

Four sided shape with no sides the same length.

Traverse

Sideways movement; the side to side movement of a machine tool.

Trepanning

A technique for making holes by cutting a cylindrical groove to remove a core, rather than machining out the entire hole. Trepanning is a particularly useful approach to machining large holes in sheet material.

Triangle

A three-sided shape.

Trigonometry

The branch of geometry dealing with triangles and the relationships between their angles and sides.

Triple expansion engine

A compound steam engine which expands the steam three times, in a high pressure cylinder, an intermediate cylinder and then a larger

diameter, low pressure cylinder. These engines make very efficient use of steam and are most typical of marine use, sometimes with a final low pressure turbine exhausting to a condenser to achieve ultimate efficiency.

Tripod

A stand with three legs.

Trolley bus

An electric bus supplied with power through overhead lines.

Troostite

A tough form of carbon steel formed by the tempering of hard martensite at temperatures from about 150 to 400˚c.

Trueing

The action of bringing a fabrication to truth.

Truncated

Cut off short, such as the lower part of a cone, without the point.

Truncated cone

A cone with the top cut off.

Truth

The accuracy of the setting of a bore, shaft or other component.

Try square

An engineers square.

T-slot

A slot, usually on a machine table, shaped to allow the use of t-nuts for clamping items in place. It is an advantage, but not essential, for the various machines in a workshop to share a common t-slot size. Caution should be taken not to overtighten fixings as t-slots can be damaged this way. T-slots should be kept clean and free of swarf as far as is practical.

T-slotted table

A workholding arrangement in the form of a metal surface with slots milled in it such that they have an inverted-T cross section. They are used in conjunction with t-nuts and t-bolts.

Tubal Cain

The pen name of Tom D. Walshaw, used for most of his writings on model engineering subjects. In the Old Testament Tubal Cain was "the forger of brass, and of iron", son of Lamech and brother (or half-brother) of Noah.

Tube

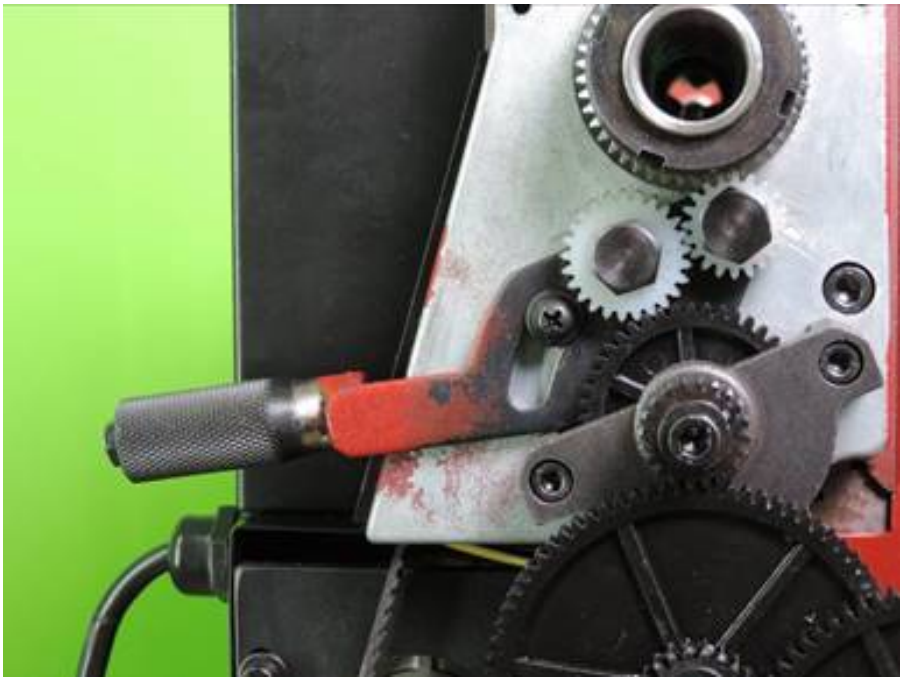
A hollow cylinder. Metal tubing is available in a bewildering range of styles and sizes. Seamless tubing is stronger and more accurate, but seamed tubing is cheaper. The thickness may be quoted directly in inches or millimetres or in SWG.

Tube cutter

A clamp-like tool with rollers opposed to a circular cutting wheel used for the convenient cutting of tubing made from the softer metals. The cutting action leaves the end of the tube slightly reduced, which may mean it needs further attention for some purposes.

Tumbler reverse

A gear arrangement used to reverse rotary motion, for example the leadscrew of a lathe.



Tungsten

A hard, grey metal; used in the manufacture of alloy steels.

Tungsten carbide

A very hard substance that can be used to mould cutting tools in complex shapes by the process of sintering.

Turbine

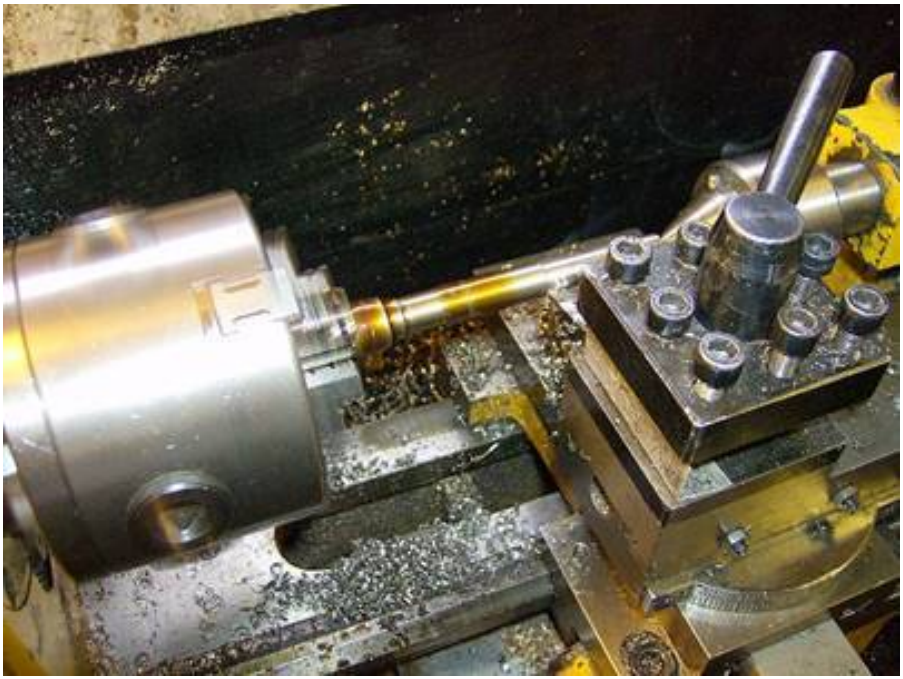
An engine that converts the energy of its working fluid directly into rotary motion.

Turners cement

Various resin (typically shellac) based compounds (Tubal Cain recommended a mixture of resin and beeswax) that can be used to attach thin workpieces to a flat surface for machining. The holding surface is warmed until the cement melts, and the work held in place as it cools. The adhesion of the cement is quite strong, but not good at coping with shock loads.

Turning

The art and craft of shaping metal using a lathe (never lathing!)



Twist drill

a drill bit for making holes typically with two spiral flutes and the end coned at 118° and backed off to create cutting edges. The great majority of drills are now of this form, typically made of high speed steel (with or without various surface treatments) or sintered tungsten carbide, though older carbon steel drills may still be encountered.

Two-dimensional

Having no depth, also used to refer to thin components on constant thickness.

Two-stroke

An internal combustion engine that fires on every rotation of the crankshaft. Ignition may be by compression, glow plug or spark. The fundamental challenge for two stroke engines is to clear the exhaust gases at the end of expansion, while maximising the charge of fresh fuel and air on the induction phase. The use of forced induction by pumping the fuel/air mixture through the crankcase is usual, and this may be enhanced by deflectors on top of the piston and special porting arrangements.

Tympan chuck

A flat plate chuck on which a piece of paper can be mounted, allowing a pen or pencil to be used to check the path of a tool in ornamental turning.

Tyre

A separate outer surface on a wheel, upon which it runs. As well as the familiar pneumatic tyres, the steel rims of wagon wheels and the outer rims (not the flanges) of the wheels of rolling stock are tyres. In full size it is normal to shrink fit the tyres onto railway wheels, but at modelling sizes it is not uncommon simply to machine a small groove to represent the joint between wheel and tyre.

Tyre profile

Railway rolling stock tyres have various profiles, common to almost all is a gently coned tread blended into a taller flange. Ideally the cone of the tread helps the wheels self-centre and the flanges serve as a precaution against derailment, and guide the wheels through pointwork. Smaller gauge models may use a simple tyre profile with no coning although current wisdom is that coning is beneficial even down to 2 1/2” gauge and below.

U

Ultimate strength

As ultimate tensile strength.

Ultimate tensile strength (UTS)

The maximum stress that a material can take under tension. Defined as the highest point on the stress-strain curve. This is the most often quoted property relating to the strengths of materials and can be useful when comparing them. It is not the whole story; for example paxolin has almost as great an UTS as cast iron, but is much more flexible and their applications are very different. A more useful property is the yield strength of a material. This defines the stress at which it is permanently deformed, and hence the point at which a component is likely to fail to function properly, if not break completely.

UNC

Unified National Coarse, an imperial standard screw thread developed during WWII to facilitate the interchange of equipment between the USA and Great Britain.

Undercutting

When gears with a small number of teeth are made to a theoretically correct form the base of the tooth will be narrower than the tooth at the pitch circle. This makes the teeth impossible to produce accurately with a standard cutter, weakens them and needs to be avoided for gears having heavy duties, although such gears can be quite practical for some purposes. For a 20° pressure angle undercutting starts at about 16. One way of reducing this problem is to use a stub-gear form, with a 30° pressure angle gears down to 11 teeth will not be undercut.

UNF

Unified National Fine, an imperial standard screw thread to complement UNC using smaller thread pitches.

Unhardened

In an annealed or relatively soft and easily machined condition.

Unified threads

Collectively the UNC and UNF thread series. The thread form has a 60° angle and a truncated form.

Unilateral tolerance

A tolerance on the size of a part that only allows variation from the nominal size in one direction. For example a shaft may be sized as 1.000” +0.000” –0.004”. Although this could be expressed as a bilateral tolerance of 0.998” +/- 0.002”, this would not emphasise the nominal size of the part.

Union

A fixing designed for connecting two parts. Typically, unions may be used to join small bore tubing, or unions in the form of long nuts may be used to extend studs.

Universal Dividing Head

A dividing head capable being set for any number of divisions up to 360. A semi-universal dividing head will generally give any number of divisions to 100. The numbers ‘missing’ from normal dividing heads are usually larger prime numbers, usually only required by makers of clocks, orreries and the like.

Universal Joint

A joint allowing rotary motion to be transmitted between two shafts that may not be exactly aligned or may move in use.

Universal milling machine

A horizontal milling machine to which a vertical milling head can be added.

Universal motor

A type of electric motor that will run on either AC or DC supplies. They have the disadvantage that in a no-load situation their free running speed is high, making them unsafe for purposes such as grinding wheels. Their speed can be controlled electronically, so they are often used for purposes such variable speed hand drills.

Unmachined

Raw material before it has been worked on.

Unsprung

Without any form of elastic suspension.

Unswept volume

The size of the space remaining above a piston when it is at the top of its stroke.

UTS

Ultimate Tensile Strength.

Vacuum

The absence of any gas within a space. Often used loosely to refer to any pressure that is less than the ambient atmospheric pressure. An absolute pressure of 0.75 atmospheres might be described as a vacuum of 0.25 atmospheres, for example.

Vacuum brake

A braking system in which the brakes are held off against springs by atmospheric pressure acting against a vacuum. In the case of a fault that breaks the vacuum lines, the brakes fail safe.

Vademecum

A handbook; small reference book such as this would be if it was on paper!

Valance

A hanging border, used to refer to the edging plates along the running boards of a locomotive or the roof of a traction engine, for example.

Valve

A device for controlling the flow of a fluid.

Valve chest

A cavity containing the valves of certain steam engines. See steam chest.

Valve gap

A deliberate allowance of lost motion in the valve gear of a poppet valve to ensure the valve fully seats itself and allow for dimensional changes as the engine heats and cools.

Valve guide

A sleeve around the neck of a poppet valve that holds it in alignment

Valve liner

An accurately bored sleeve with carefully proportioned ports in which a piston valve operates.

Valve rocker

Levers that allow the push-rods of an a overhead valve engine operated by a conventionally placed camshaft (adjacent to the crankshaft) to act on the ends of the valves.

Valve seat

The round surface against which a poppet valve seals. For the best performance valves should be ground into their seats. Valve seats may be made of different materials from that of the engine block in which they are fitted to increase their wearing properties. They may also be made in one piece with the valve guide.

Vanadium

The hardest metallic element; used in alloy steels. Vanadium steel is hard strong and tough. It hardens very deeply and has good impact resistance. It is hard to machine, but is often used for forged tools.

Vane

A narrow blade used to align the flow of a fluid.

Vaporiser

An early method of producing a combustible fuel/air mixture use in simple internal combustion engines. Instead of using venturi to create a fine spray of volatile fuel, a vaporiser uses heat (typically generated by the exhaust system) to evaporate the fuel.

Vapour

A gas in equilibrium with a liquid, such as wet steam. Vapours do not follow the gas laws and behave very differently as when their temperature or pressure changes they move between their two phases. This is why the behaviour of a steam engine can be very different when powered by compressed air.

Variable frequency drive

An electronic motor driver that converts an AC supply to DC, then uses an inverter to produce three-phase AC. By changing the frequency of the three-phase output thespeed of a driven motor can be accurately controlled.

V-belt

A reinforced rubber belt with a triangular cross-section, capable of transmitting more power than a flat belt of similar size.

V-block

A precision ground metal block with a large v-shaped notch in one side, often hardened and often supplied in matched pairs, used for supporting work for machining and marking out. V-blocks are ideally suited to holding round work, but may also be used to hold other shapes. They are often, but not always, supplied with matching clamps to facilitate workholding.

VCI

Volatile Corrosion Inhibitor.

Vector

Something that is definable both in its magnitude and direction. For example the mass of a body is not a vector, but when at rest its weight is a vector (a force equal to its mass x G, in the direction of the centre of the Earth).

Vehicle

A means of conveyance.

Velocity

A vector quantity comprising speed and direction.

Verdict

A popular brand of dial gauge, often used as a generic term by older machinists.

Verify

Confirm to be true; check.

Vernier

A short movable scale set out so that, by determining which of the points on the vernier scale is best aligned with a fixed scale, one can judge smaller parts of the fixed scale. Typical applications include many measuring devices, devices which must be set to a precise angle or position, barometers and manometers. (2) casual term for a vernier calliper.

Vernier calliper

A linear measuring instrument for making internal and/or extrenal measurements incorporating a vernier scale for high precision readings, typically 0.001" (0.02mm). Digital verniers are callipers that use electronic sensors, not a vernier scale, to read to similar levels of precision.

Vernier height gauge

An accurately mounted vertical vernier scale bearing a hardened pointer, and normally used in conjunction with a surface plate. By zeroing its reading it may be used for absolute or relative measurements. Electronic digital types are available.

Vertex (plural vertices)

Point or apex, the corners of a geometric figure, loosely used to refer to the highest point on an object.

Vertical

At right angles to the horizontal, an object arranged so its main axis is in an up-down direction.

Vertical milling machine

A mill which has a vertical spindle (though it is often possible to tilt the spindle by around 45° to either side). Vertical mills are generally more versatile than horizontal mills which makes them the likely choice for most model engineers though they are generally less rigid. Benchtop vertical mills may superficially resemble a pillar drill with an x-y table, but are much more robust.

Vertical slide

A slide-mounted workholding table intended for mounting on the cross-slide of a lathe in order to facilitate milling and other operations requiring movement on a third axis. Most vertical slides have t-slotted tables; they may only allow vertical movement, or they may have facilities to rotate the table around one or more axes for greater flexibility (often at the cost of rigidity and travel). With the typical ingenuity of model engineers there are many other ways in which such a device may be used. One example is mounting a milling spindle on the slide allowing it to be used to machine work held in the chuck.

Vertical steam engine

A steam engine in which the axis of the cylinders is vertical, particularly used to describe engines with the crankshaft below the cylinders

VFD

Variable frequency drive.

V-groove

A slot with a cross section in the form of an equilateral or isosceles triangle.

Vibrational energy

Energy within a system that is stored by continually passing back and forth between kinetic energy and potential energy. Examples would be a swinging pendulum or a weight bouncing on the end of a spring. Less obvious examples include sound (where the energy is a vibration of the air molecules) and ultimately heat, which, as the chaotic vibration of individual molecules, is generally seen as where all energy ends up through entropy.

Vice

A workholding device comprising two opposed jaws. A bench vice is a robust vice used to hold work for hand working. Machine vices may be used to hold work in place for operations such as milling or drilling.

Vickers hardness test

To determine the Vickers hardness of a metal sample a pyramidal diamond stylus is pressed into a sample under great pressure, sustained for several seconds. The size of the resulting depression is used to calculate the hardness of the sample.

Vickers number

A number indicating the hardness of a material, the higher the number the harder the material. A range of different steels might have numbers across the range 120 to 280; copper might range from 50 to100 depending on its condition; brasses from 80 to 140; and bronzes

as high as 160.

Volatile

With a low boiling point; easily evaporated.

Volatile Corrosion Inhibitor (VCI)

An organic compound that slowly evaporates and (when used in a suitably small and enclosed space) offers a degree of protection against rust. Typically a tin of VCI will protect a space of a few cubic feet for a year or more.

Volt (V)

The standard unit of electrical potential.

Vulcan

Roman god of fire and metal working.

Vulcanising

The process for turning raw rubber into a hard, resilient compound by adding sulphur and heating it.

W

Wall pressure

The force exerted by a piston ring on the wall of its cylinder. Frictional losses caused by excessive wall pressure can be a problem in small engines and rings should be chosen to give the minimum pressure required for satisfactory operation.

Walschaerts valve gear

A common form of valve gear used on steam locomotives, using a series of levers driven from a single eccentric pin.

Walshaw. Tom D.,

See Tubal Cain.

Warp

A twist along the length of an object. Warping can be caused by machining stressed objects such as castings or drawn metal. In castings such stresses may be relieved by ageing, in the case of drawn or worked steel normalising is effective. Minor warping can cause inaccuracies in machine tools which can usually be addressed by careful alignment.

Washer

A thin, flat disk with a central hole. Metal washers may be used to spread the load borne by a nut or prevent damage to a surface. They can also be used to space rotating components. Washers from rubber, fibre and soft metals can serve to provide a good seal for threaded plugs and similar fittings.

Watchmaking

The craft of making small portable mechanical timepieces. Much watchmaking is done with hand tools or gravers using special small lathes, and the techniques involved are often very different from those of everyday engineering.

Water gauge

1. Pressure expressed as the height to which it will raise a column of water.
2. A water-filled manometer typically used for testing low-pressure gas supplies.
3. Glass tube used to show the level of water in a vessel such as a boiler.

Water jet cutting

A technique for generating detailed shapes in sheet metal using a water jet loaded with abrasive particles, rivalling laser cutting although producing greater ‘flare’ on thick sheet.

Water of crystallisation

Water trapped within the crystals of a chemical compound. The evaporation of water of crystallisation is the cause of flux (especially borax) ‘fluffing up’ on heating and potentially disturbing the alignment of parts.

Water vapour

The gaseous phase of water in equilibrium with the liquid phase.

Waterglass

An aqueous solution of sodium silicate

Effectively dissolved glass or sand. It can be used to fuse glass or sand, for example it can be used to ‘set’ cores for casting. When wet with waterglass, infusing cores with carbon dioxide acts to accelerate setting.

Watt

Unit of power, particularly in the context of electricity.

Watt (W)

The SI unit of power, that required to move the point of application of a force of one newton at velocity of one metre per second. One kilowatt (kw) = 1.34 hp.

Watt governor

A machine governor operated by two heavy balls on the end of

rotating arms.

Watt. James,

A gifted inventor and astute businessman who greatly improved the efficiency of steam engines by his invention of the condenser and other improvements. Ironically his dogged defence of his patents and resistance to later innovations, such as compounding and high pressure working, slowed further progress.

Wavelength

The minimum distance between two points at the same position on a wave's cycle.

Wavy parallels

Paired sinuous bars that have been ground parallel on their two long edges. As well as serving as ordinary parallels, they can also be used as spring clamps.

Wax

Long chain hydrocarbons that are solid at normal temperatures.

Web

A relatively thin section of a component between other thicker parts that acts to increase strength and rigidity, such as the web between the flutes of a twist drill.

Wedge

A prism of triangular cross section.

Wedge angle

The angle the front of the cutting surface of a tool makes with the work, the angle at which the cutting edge is driven into the work to create a chip. A smaller wedge angle therefore cuts more freely, but makes a more delicate tool and is more likely to be pulled into the work and cause chatter. A larger wedge angle is more robust, but requires greater power. As the wedge angle reduces the rake of the tool increases.

Weighshaft

A shaft with linkages whose function is to translate linear movement at one end into a similar movement at the other end. Often used for brake or valve linkages across the frames of a locomotive, for example. Contrast with a jackshaft that transmits rotary motion.

Weight

1. The force exerted by a mass on a supporting surface, under the influence of gravity.
2. An object whose function is to concentrate force at a certain point, as in a counterweight, balance weight or a paperweight.

Weld

The joining of metals by fusing them together, if filler metal is used it is normally of similar composition to the materials being welded (in contrast to soldering and brazing).

Welding rods

Filler metal rods for welding. MMA rods (known as ‘sticks’) are coated in flux, but rods for gas welding usually only have a thin copper coating to protect them from corrosion.

Welding torch

A type of gas torch that uses both a fuel gas (such as propane or acytylene) and oxygen to obtain very high temperature flames for welding metal through local fusion. Such torches require many safety precautions and considerable skill in use. They can be used for many other purposes including brazing and heat treatment.

Well tank

An arrangement of water tanks between the frames of a locomotive. Due to the limited capacity this is not a popular configuration for models.

Westbury, Edgar T.

One of the most remarkable model engineers, E.T.W. designed many internal combustion engines and stationary steam engines. His sole locomotive design was an IC powered diesel outline. He also designed the Dore-Westbury milling machine, sold as completed machines or a set of part-machined components for home finishing.

Wet

The action of a liquid overcoming surface tension and spreading across a surface. One of the functions of a flux is to encourage solders and brazes to wet the metal being joined.

Wet and dry paper

Water resistant abrasive paper, usually based on carborundum, available in many grades. In the workshop it is best used dry, or with oil as a lubricant.

Wetting

The action of a liquid in spreading over and contacting a surface. To be effective paints and adhesives must wet a surface and cleanliness (especially the absence of oil) is an important prerequisite. Similarly for successful soldering or brazing it is essential that the filler metal wets the materials to be joined, and fluxes play an important role in promoting this.

Wheel

A object, usually circular, that rotates around its central axis.

Wheel dresser

A device with several star-shaped wheels in a head designed to hook on the toolrest of a bench grinder and then to be pivoted into the wheel. The action of the dresser is to rapidly bring the surface of the wheel back to a good finish.

Wheel profile

It is essential that the profile of wheels for locomotives and rolling stock is carefully produced in order to prevent excessive wear to both the wheels and the rails on which they run. It is normal for the tyre of such wheels to be coned, and have a defined curve into their flange to promote self-steering and prevent the wheels ‘running on the flange’. Most drawings for model locomotives show a suitable wheel profile, but when using older drawings it is worth checking with an expert to see if a more modern profile would be preferable.

Wheelset

A set of wheels and their axles taken as a unit.

Wheelwrighting

The craft of making wooden vehicles, not just their wheels.

Whetstone

A fine grinding stone or wheel designed to be used wet for the final honing of tools, rather than removing large amounts of metal.

Whipping

A technique for securing the end of a rope against unravelling by binding it with rather finer cord.

Whistle

A tuned sound making device operate by a blast of air or steam.

White iron

Cast iron that has been rapidly cooled, so that almost all of the carbon in it is in the form of iron carbide (cementite), a very hard material in common with other carbides. It is a very hard, brittle, intractable material, but can be readily ground to give hard wearing surfaces. The use of chills allows areas of white cast iron to be deliberately created where bearing surfaces are needed.

Whitworth thread form

An imperial screw thread with an angle of 55˚, see BSW and BSF.

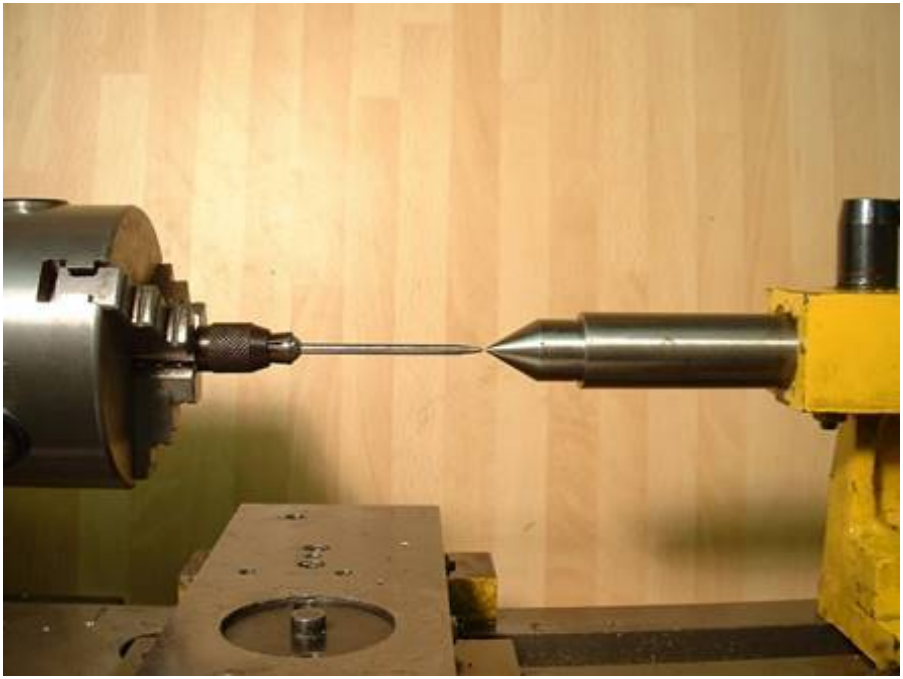
Whitworth. Sir Joseph,

Victorian engineer responsible for the introduction of precision measurement and standardisation into engineering. After carrying out a survey of the various screw threads used across industry, he devised the Whitworth thread form and series of screw threads.

Wiggler

A development of the sticky pin, typically a pointed probe mounted in a ball and socket joint that may be held in a chuck. When spun in the chuck the wiggler may be brought to truth by gently holding a piece of bar or the edge of a rule against it. Once the wiggler is turning with

no perceptible movement of its tip, it is precisely centred and may be used as an aid to setting up, for example by picking up a centre.



Wilkinson, John,

Inventor of an improved process of steel making, by burning out all the carbon then adding as much as was needed, supposedly a solution suggested by his young daughter.

Wipers

Typically rubber or felt strips fitted to moving parts of a machine tool to prevent swarf or other contamination from becoming trapped in the slides.

Wire

A single, flexible metal filament, normally produced by drawing the material through a succession of smaller dies.

Wire erosion

A method for machining very accurate parts to a high standard of surface finish using high voltage and a continually replenished wire electrode under the cover of a suitable fluid. Wire erosion can be used to cut through very thick metal and can create complex shapes

including tapers.

Wire gauge

A number of systems for denoting the thickness of wire by means of numbers. The numbers relate to how often the wire is drawn through a die to make it thinner so typically bigger numbers mean finer wire. As several different wire gauge systems co-exist, it is generally best to specify the actual diameter needed.

Wood

One of the earliest engineering materials. As well as representing wooden parts of original prototypes, it may be used for handles, brake blocks. When a jig or fixture is needed at short notice without a long life, almost any piece of sound wood can be used. Few woods have the wearing properties or dimensional stability for general engineering purposes, but there are exceptions including ebony and Lignum vitae.

Wood screw

A screw with a tapered tip and a deep, sharp-edged thread intended to tap its own holes in wood or similar materials. Ideally a pilot hole should be drilled for all wood screws, and this is essential when using brass screws or screwing into wood with a tendency to split.

Woodruffe cutter

A circular cutter for making suitable sockets for woodruffe keys. Resembling a thin t-slot cutter they are also useful for cutting grooves. They are often used for grooving connecting rods; George Thomas pointed out that such grooves should have rounded, not square, corners and advocated making a home made tool for such purposes.

Woodruffe key

A semi-circular key that fits in a matching pocket in a shaft. Such a key normally fits entirely within the boss of the surrounding component that has a normal straight keyway.

Woodworking lathe

A lathe for turning wood. There are many detail differences in construction compared to a metal turning lathe, but the most fundamental is that in woodturning the tool is invariably hand held with the assistance of a rest, in contrast to using a fixed toolholder on

a moveable saddle.

Woolf compound engine

A compound beam engine with both a high and a low pressure cylinder on the opposite side of the pivot to the flywheel.

Work

Work done is defined as the distance moved by the point of application of a force. Whenever work is done, energy is converted from one form to another. When a ball sits on a shelf under the force of gravity, it does not move and no work is done and no energy expended. If it falls off the shelf, work is done in proportion to how far it falls; the ball's potential energy becomes kinetic energy. When it hits the ground and bounces to a stop the energy gets converted into heat and sound. From a model engineering perspective, our objective is typically to find ways of taking stored in one form (potential energy, chemical energy, electrical energy, thermal energy) and get them to do useful work by converting them into kinetic energy in our models (i.e. Get them to move about).

Work hardening

The hardening of metals caused by cold working, often accompanied by a degree of embrittlement. As a metal is subjected to shock loads or deformation, the crystals within its structure move and 'lock' together reducing its ductility. It can be used to advantage, for example when a copper pressure vessel in the annealed condition is first stressed it is able to deform, reducing stress concentrations. This process also causes some work hardening, making it more resistant to future deformation. Another example would be beating brass strip with a hammer to harden it and make it more suitable for use as a spring. Work hardening can cause problems during machining, for example some stainless steels work harden so rapidly that a brief pause while drilling can be enough to render the metal hard enough to blunt the drill bit. Work hardening of most metals can be reversed by annealing.

Work table

The surface of a machine tool to which the workpiece or other workholding devices held. Normally provided with T-slots but sometimes provided with tapped holes.

Workhead

In certain machines, the operating part containing the tool, rather than the ancillary parts.

Workholding

The broad and complex subject of ways of securing work in order to keep it secure whilst presenting it correctly to the tool. As general principles work should be clamped at two or more widely separated points and ideally supported so that it is constrained against movement in all three dimensions.

Working fluid

The fluid whose expansion provides the means of driving an engine. It may be a liquid (hydraulic drive), gas (hot air engine) or vapour (steam engine). A particularly unusual example of a working fluid is naphtha, which enjoyed brief popularity despite the obvious risks.

Working life

The expected lifetime of a tool or machine, heavily influenced by how hard it is worked, how often and the regularity and quality of maintenance. With regular attention most machine tools have an indefinite working life. In industry, cutting tools will be worked to give the most cost effective balance between efficiency and long life. In the home workshop, where time is rarely a major constraint, tools may be worked more gently and have longer lives.

Workpiece

An object on which machining operations are carried out.

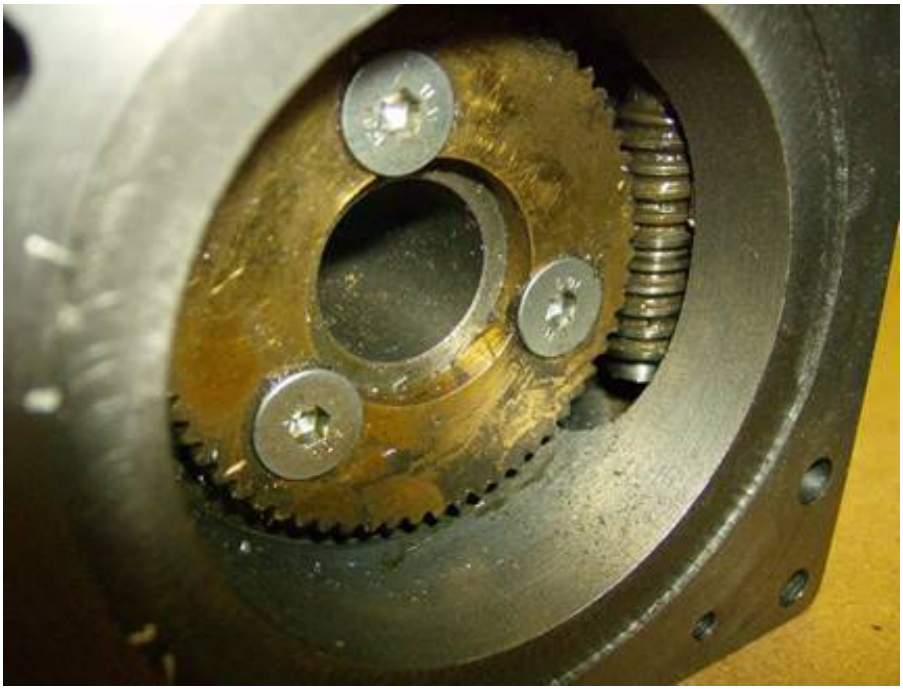
Workshop

The room or dedicated space in which work is carried out. Typically the workshop will have a range of machine tools as well as areas for handwork, assembly, hot work, painting or other tasks.

Worm and wheel

The pairing of a worm wheel and a worm gear to achieve considerable reductions in a single step. The reduction ratio is given by (number of starts on the worm)/(number of teeth on the gear). The worm should always drive the gear, which cannot be expected to drive the worm efficiently. Even so, it should not be assumed that a worm and wheel are incapable of being driven backwards in safety dependent

situations.



Worm gear

A gear in the form of a helical screw thread along a cylinder, effectively it is a cylindrical gear with one or more spiral ‘teeth’ around its circumference. The number of such ‘teeth’ is described as the number of starts of the worm. Worm gears are used in conjunction with a worm wheel.

Worm wheel

A gear with teeth formed to engage with a worm gear, typically by being angled to conform to the helix angle of the worm.

Wrench

1. A spanner (especially in the USA), most often an adjustable one.
2. Any tool that acts as a lever for tightening or turning.

Wring

Bring two objects together with a twisting motion, for example to get a tight fitting shaft into a hole. It is possible to wring two very flat and clean surfaces (such as two gauge blocks) together by molecular

adhesion.

Wringing fit

A fit between two parts such that one has to be twisted onto the other.

Wrought iron

Very pure iron produce by the process of puddling which effectively burns out all of the carbon. Wrought iron is a durable but relatively soft metal that is easily worked, although stringy inclusions of slag can rapidly wear tools. Wrought iron is no longer produced on an industrial scale.

X

X-axis

1. The first or prime axis of a machine tool, typically that which moves left and right relative to the operator.
2. By convention the horizontal axis of a graph, usually used to plot the ‘controlling quantity’ such as time or the position of a piston.

Xanthophyll

A yellow plant pigment, an excuse for a second entry in this section.

Y

Y-alloy

The aluminium alloy LM14.

Yarn, Graphited

A cotton cord of round or square cross-section that is loaded with particles of graphite. The graphite lubricates the yarn when packed into a gland to make it steam tight.

Y-axis

1. Usually the second axis of a machine tool, typically that which moves back and forth relative to the operator.
2. Conventionally the vertical axis of a graph, usually used to plot the ‘output quantity’ that changes as a result of change in the ‘controlling quantity’ plotted on the x-axis.

Yield point

When an object is stretched the force required will increase until its yield point is reached, after which it will extend without an increase in the applied force. This is usually accompanied by noticeable necking of the material. A material that shows this dramatically is the plastic used to hold drink cans in fours

When stretched it will suddenly give and become much longer and thinner. Some materials do not have a defined yield point. When an object is stretched by to less than its yield point it will normally return to its original length when the applied force is removed. Forces that stretch an object beyond its yield point result in permanent distortion or a set. Some substances do not have a fixed yield point, as distortion takes place over a range rather than at a fixed point.

Yield strength

The maximum stress that can be applied to a material without causing permanent deformation. For materials without a clearly defined yield point and for these a stress resulting in a defined amount of set or strain is used (typically an extension of 0.1 to 0.2%). As we are usually interested in making parts that will not change shape when they are used rather than fail catastrophically, yield strength is more

useful than ultimate tensile strength, although the latter is usually easier to find out.

Yoke

A y-shaped part with a bearing in each arm used as part of a flexible joint.

Young's modulus

The modulus of elasticity of a material.

Z

Z-axis

1. The third axis of a machine tool, typically an up and down movement.
2. In a graph the third or z-axis would normally be that normal to the plane of the paper, though it may be represented by employing various conventions for illustrating three-dimensional shapes.

Zenith

High point, particularly in the progress of a heavenly body across the sky, the sun reaches its zenith at noon.

Zero

1. Nought, nothing.
2. The starting point of a graduated scale.
3. The action of setting a variable scale to its starting position. When zeroing index wheels care should be taken to note the direction of approach, and always to use this direction to ensure that the effects of backlash do not cause errors.

Zero flute countersink

A countersink or hole deburring tool of conical form with an angle hole instead of a flute to serve as a cutting edge.

Zero voltage switch

A switch that automatically turns off a machine automatically when power is removed. The machine can only be restarted deliberately. This eliminates the danger of machines ‘springing into life’ after a power failure or if they are connected to the supply in error. Such devices are mandatory in industry and are increasingly found on ‘hobby’ tools. They can be bought as single units for use on home-made tools, or wired using suitable relays by persons with appropriate electrical expertise.

Zinc

A soft, greyish metal of little use for engineering purposes in its pure form, but a component of brass and also used to galvanize steel as a method of rust protection.

Zinc Chloride

A chemical compound that has considerable efficacy as a flux (see killed spirits), particularly for soft soldering. It is, however, very corrosive and should always be completely cleaned off the workpiece, and should never be used for electrical work.